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Wireless World

JUNE 1964 Two ~~Shillings and Sixpence~~ 2/9

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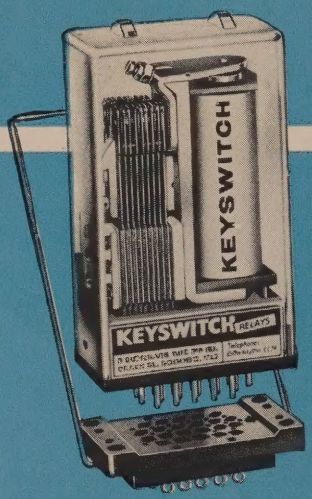
Every Keyswitch relay is painstakingly tested, mechanically and electrically—not one leaves the works unless it conforms to the most exacting specifications.
Keyswitch exactness leads all along the line in ■ price ■ precision ■ reliability ■ delivery—any relay can be delivered within 10 days.



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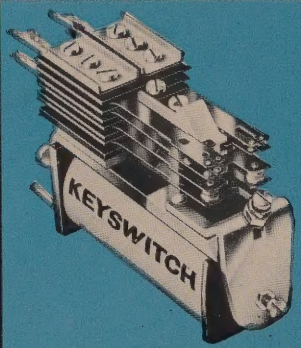
(P-33) Plug-in 3000 type relay. C.E.G.B. approved. Many variations available.



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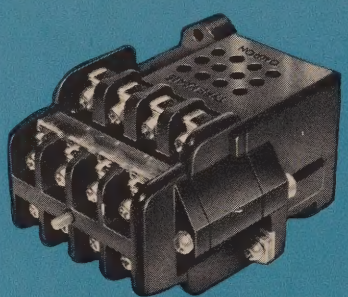
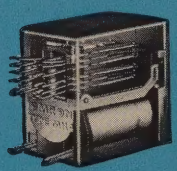
B.P.O. 3000 type major relay. C.E.G.B. approved. Many variations available.

KEYSWITCH
B.P.O. 600 type minor relay. Small size coupled with higher switching speeds.



KEYSWITCH OMRON GOLD
MA415. Plunger type (multi-contact auxiliary relay) 220v. & 440v. AC for production machines and control panels.



KEYSWITCH OMRON GOLD
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KEYSWITCH OMRON GOLD
1051. Sub miniature relay. Snap-action 5 amp contact. 6v.–50v. DC only.

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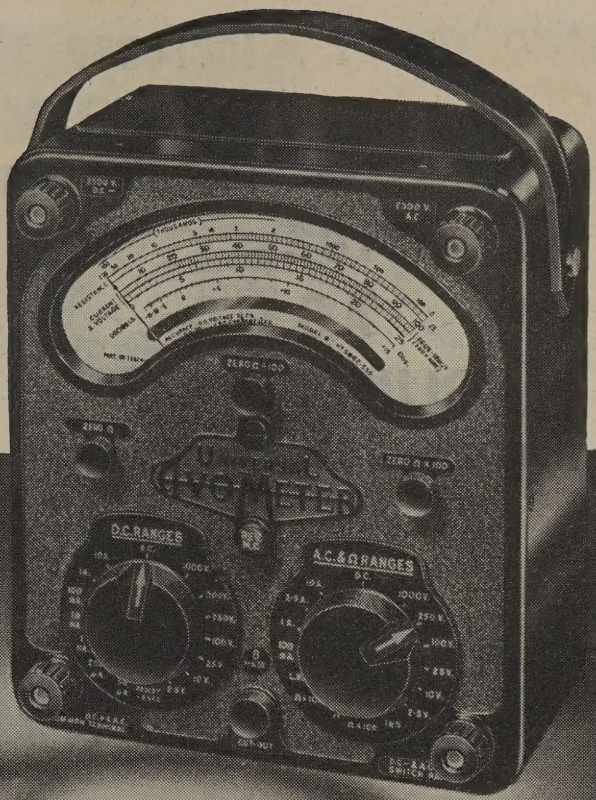

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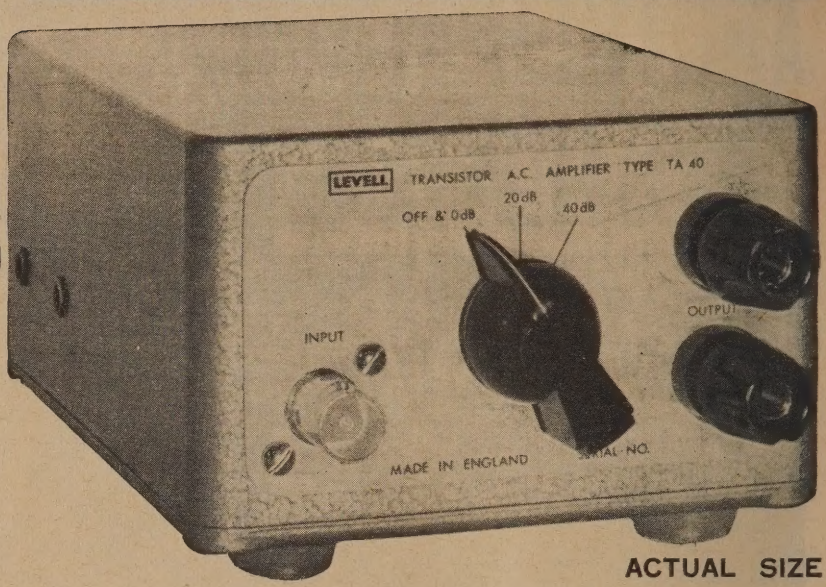
TYPES TA40 & TA60



ACTUAL SIZE

SPECIFICATION

GAIN:	TA40: 20, and 40dB. TA60: 20, 40, and 60dB. Straight through connection on 0dB.
FREQUENCY RESPONSE:	±0.5dB, 10c/s to 250kc/s at 20dB and 40dB. 15c/s to 50kc/s at 60dB. ±3dB, 4c/s to 400kc/s at 20dB and 40dB. 10c/s to 200kc/s at 60dB.
OUTPUT VOLTS:	1.5V r.m.s. into 10kΩ
OUTPUT IMPEDANCE:	80Ω approx. at 20dB and 40dB. 150Ω approx. at 60dB.
NOISE LEVEL:	50μV r.m.s. equivalent input at 20dB and 40dB with 100kΩ source. 30μV r.m.s. equivalent input at 60dB with 100kΩ source
INPUT IMPEDANCE:	3MΩ and 10pF at 20dB and 40dB. 0.25MΩ and 50pF at 60dB.
SUPPLY:	Self-contained 9V battery, life 1000 hours, or A.C. Mains when a Power Unit is fitted.
SIZE:	2½in. high x 4in. wide x 5½in. deep.
WEIGHT:	2½ pounds.

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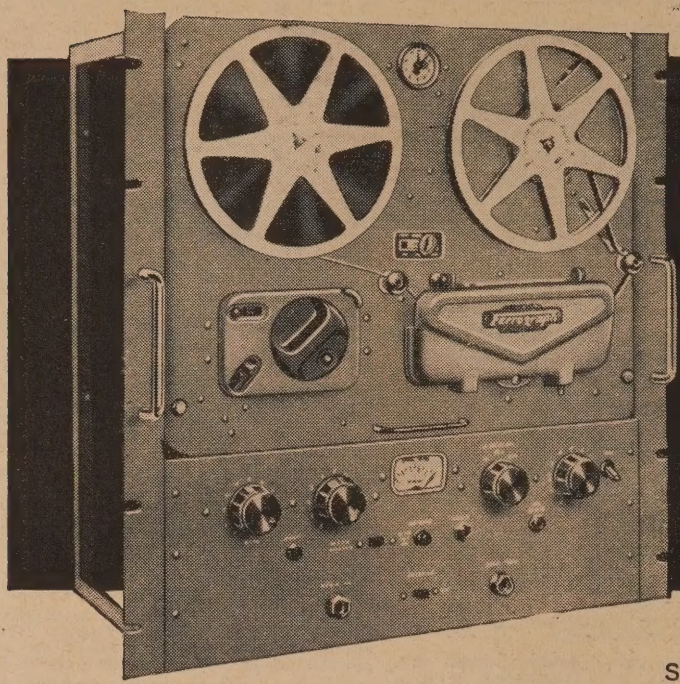

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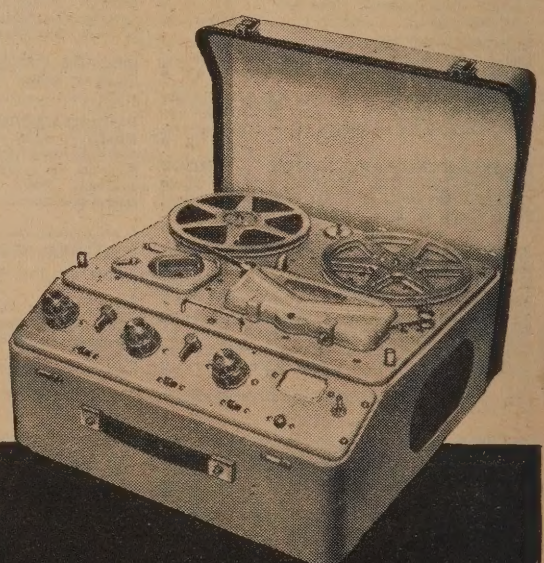
Y532A	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	117V	60 c.p.s.
Y532E	$7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ i.p.s.	110V	50 c.p.s.
Y522UH	15 and $7\frac{1}{2}$ i.p.s.	200/250V	50 c.p.s.
Y522HA	15 and $7\frac{1}{2}$ i.p.s.	117V	60 c.p.s.
Y522HE	15 and $7\frac{1}{2}$ i.p.s.	110V	50 c.p.s.



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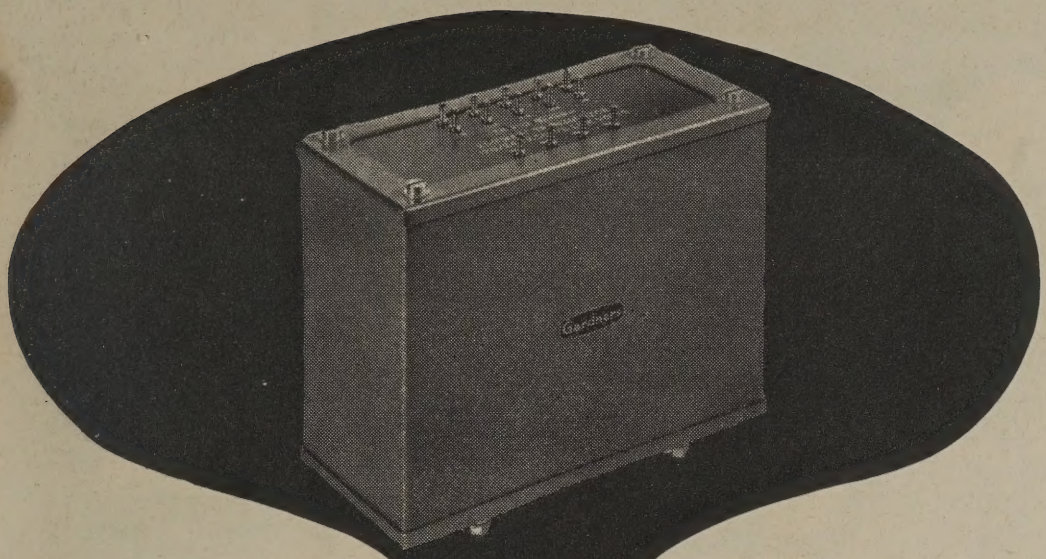

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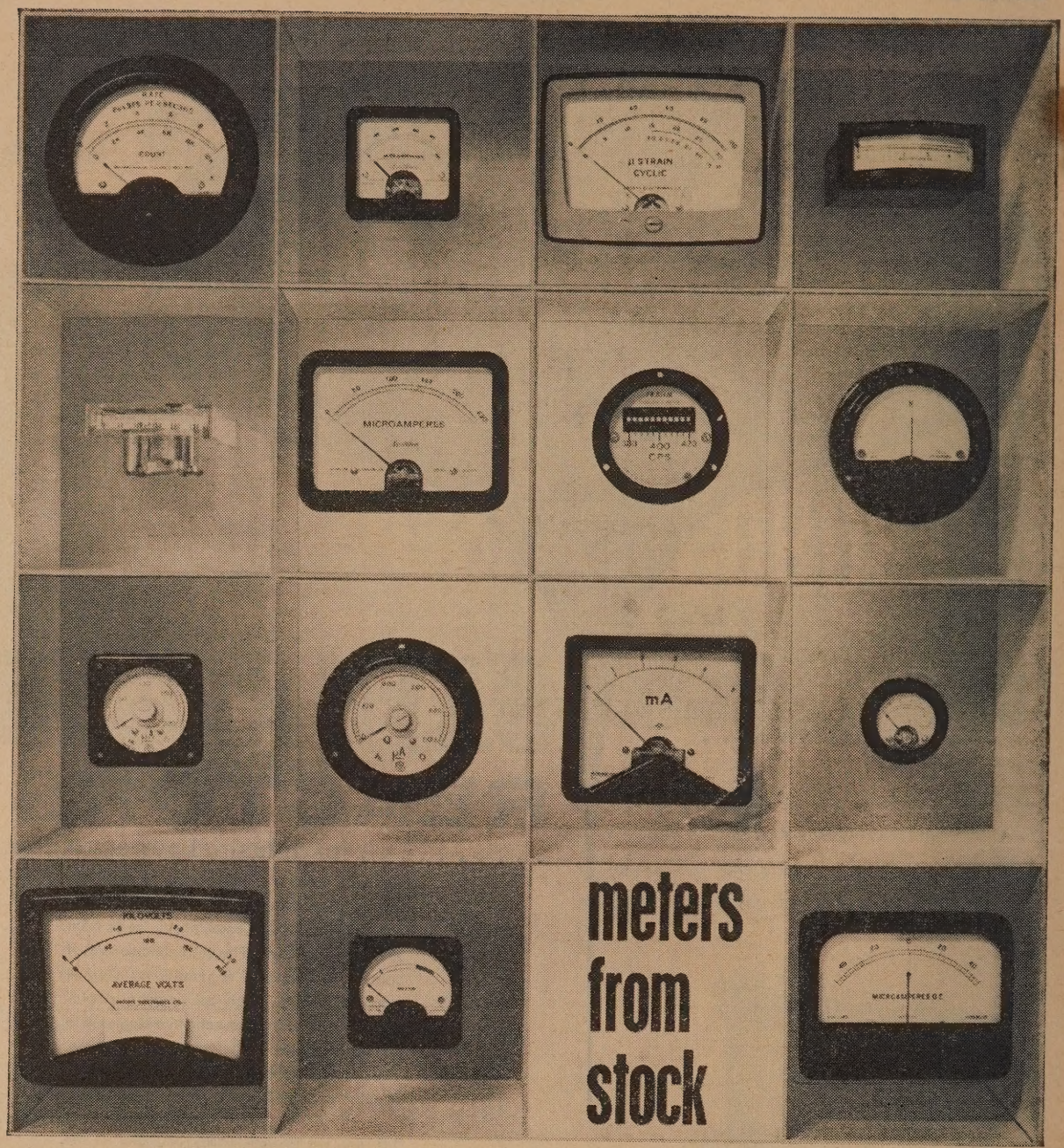

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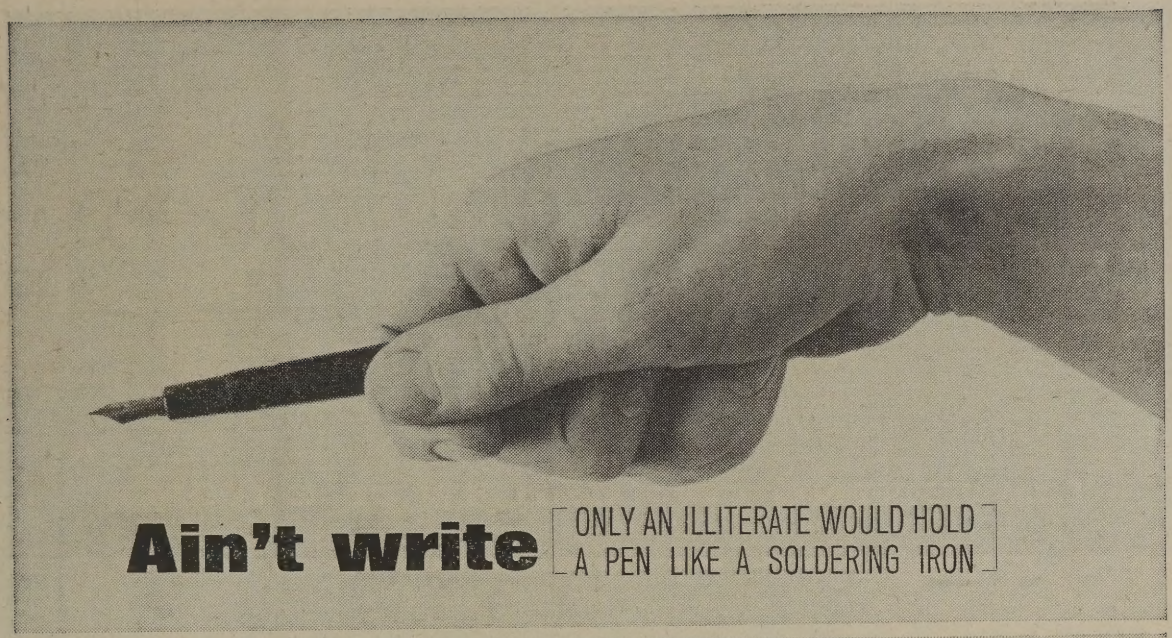

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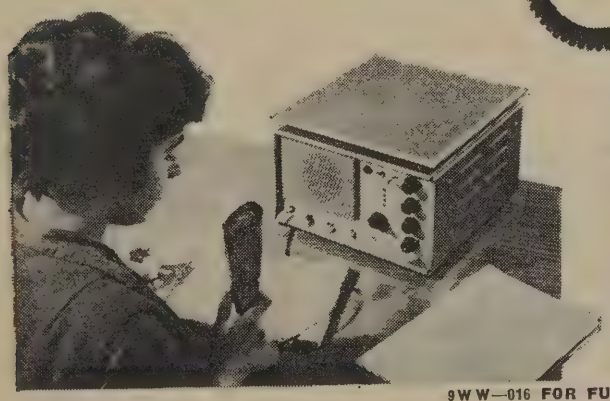

Features

- 125 watts p.e.p. output
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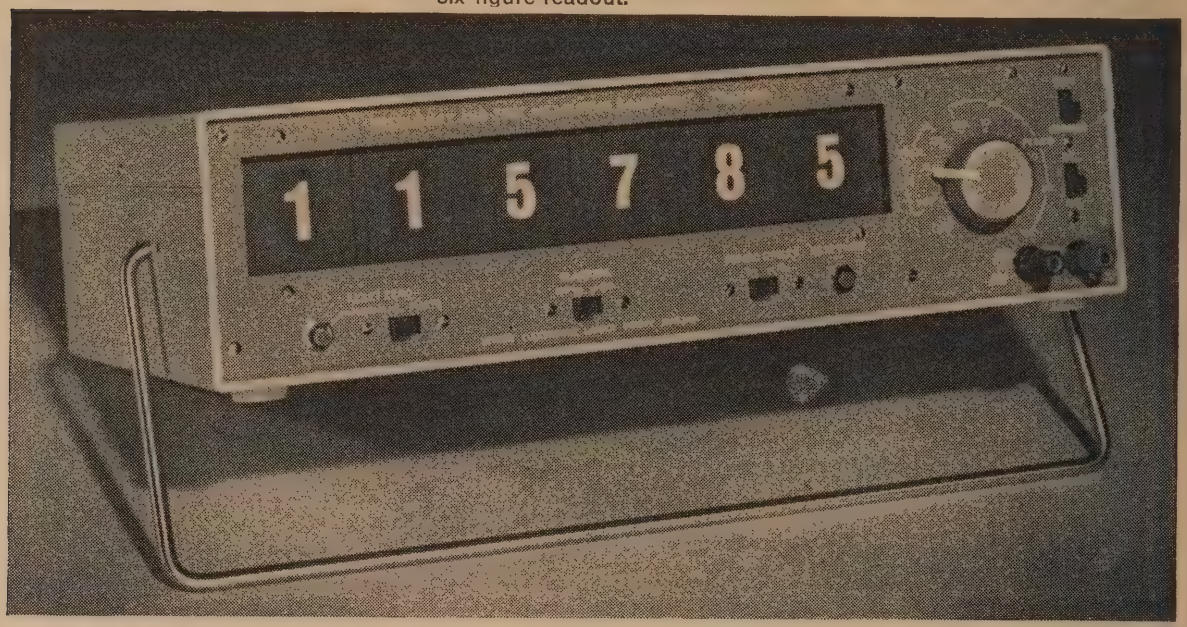

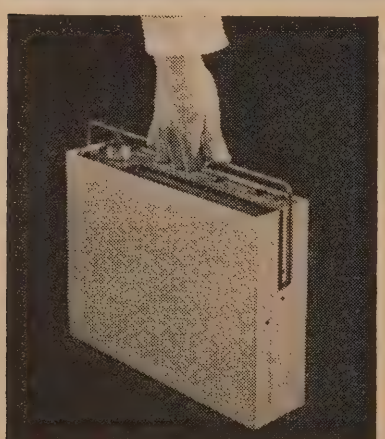

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WEIGHT - 4 GRAMMES

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Temperature	320°C
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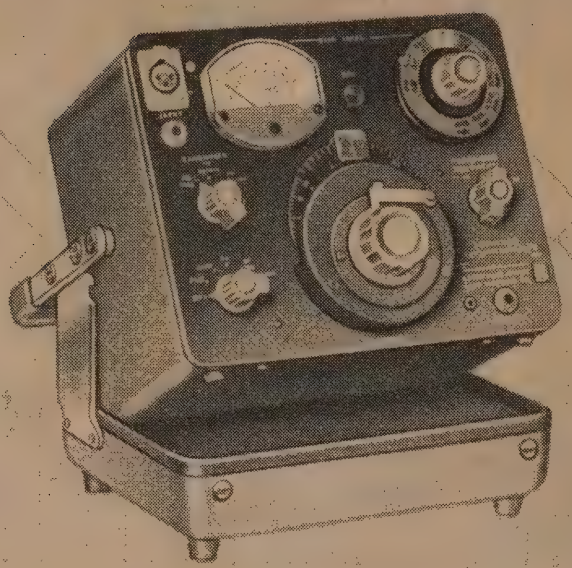

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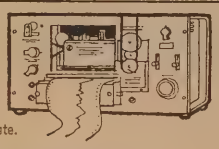

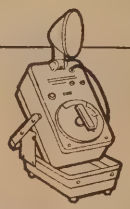

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Ultra-short high intensity flash.
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Weight less than 2 lb.
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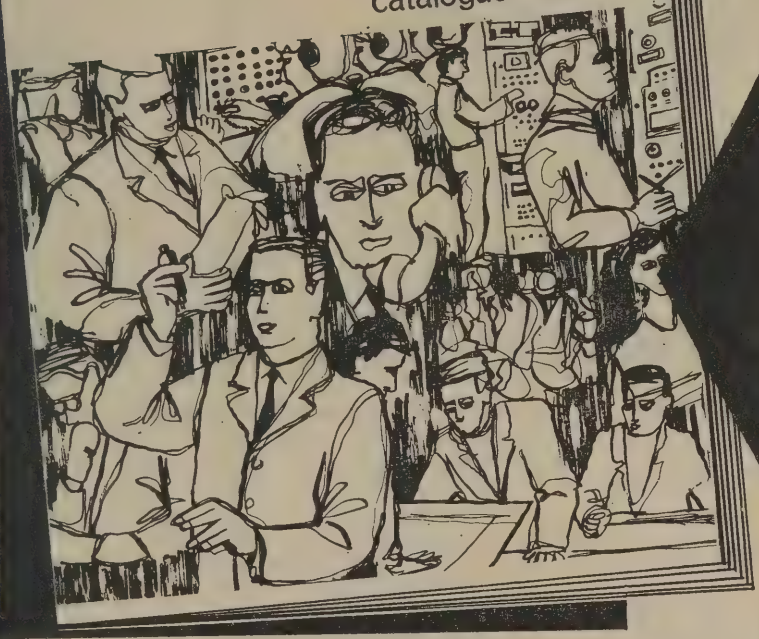

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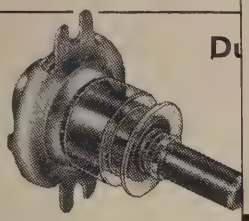

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Designed for use in mini
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The front (aerial) section
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which may be padded t
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robust yet lightweight.
Front area 1⅜ x 1 17/32
1 1/32in. deep.

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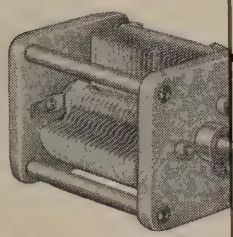

- 1,000 v. up to 500 p
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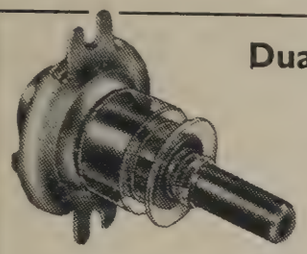

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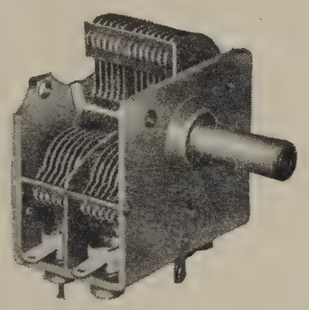

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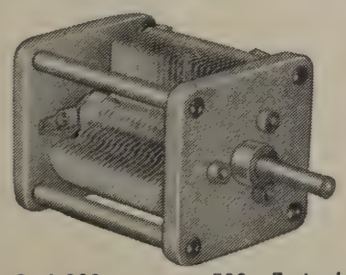

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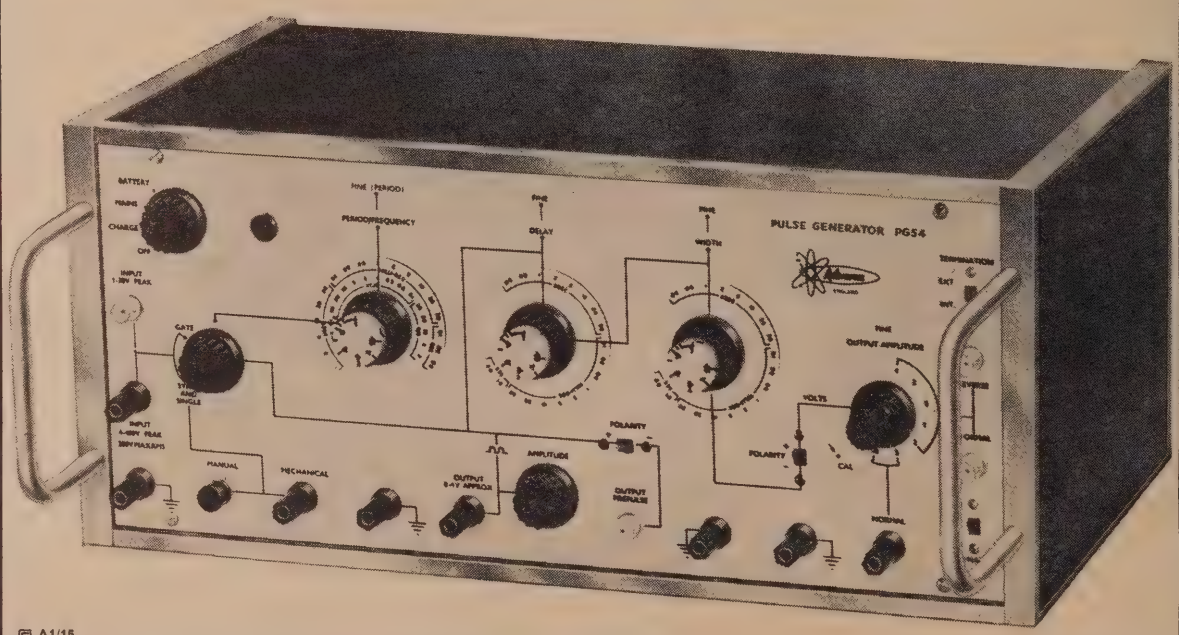

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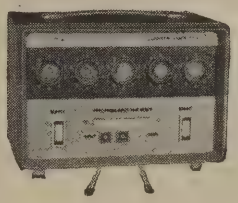
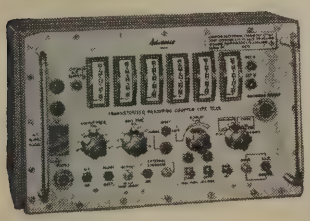
YOU CAN COUNT ON Advance

The Advance range of Timer Counters solves numerous problems. Any quality or condition which can be expressed in the timer counter language of random or regular pulses can be measured with accuracy, reliability and maximum operating economy. The ancillary equipment is designed to give even greater flexibility in the application of this range.

TC1A a fully transistorised six-digit 1 Mc/s Timer Counter with sensitivity of better than 100mV r.m.s. V.L.F. position gives frequency measurements down to Oc/s. The oven controlled crystal oscillator is accurate to 1 part in 10^6 at 25°C.
Nett price in U.K. £390

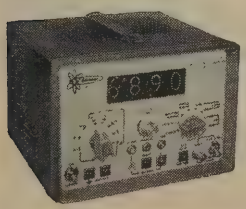


SC1 a low cost, 5 Dekatron Counter for counting regular or random pulses up to a maximum rate of 20,000 per second and time up to 999 seconds in hundredths of a second.
Nett price in U.K. £80

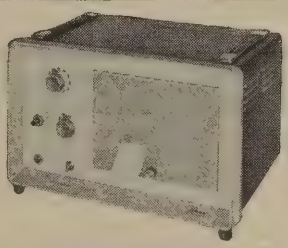


TC1S (CT463) Service approved version of the TC1A, which can be battery operated. Regular or random pulses may be counted up to a rate of one million per second. Maximum use has been made of transistors and printed circuit boards in the construction of this instrument.
Nett price in U.K. £475

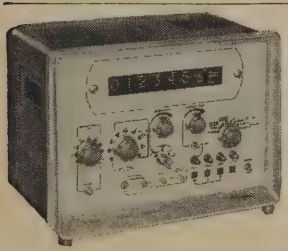
OFS1 a low cost high stability frequency standard for timer counters. It is locked onto 200Kc/s B.B.C. Light Programme and gives outputs of 100 Kc/s and 1Mc/s. Long term accuracy is 5 parts in 10^9. Simple conversion to battery operation for field use.
Nett price in U.K. £70



TC2 this new, low cost, general purpose Timer Counter with four-digit display can carry out all the functions of its six-digit counterparts; five gate times instantly resolve six-digit frequency measurement with automatic placing of the decimal point.
Nett price in U.K. £195



PR1 electro-mechanical printer designed to operate in conjunction with electronic counter or similar instrument. Seven in-line display is produced on 2" paper by ordinary typewriter ribbon—8000 impressions per roll.
Nett price in U.K. £250



TC10 the seven, in-line, edge-lit indicators of this 10Mc/s Timer Counter display measurements of regular or random electrical pulses up to a maximum rate of 10 million per second. Outputs are provided to feed Advance seven-digit electro-mechanical printer PR1.
Nett price in U.K. £695

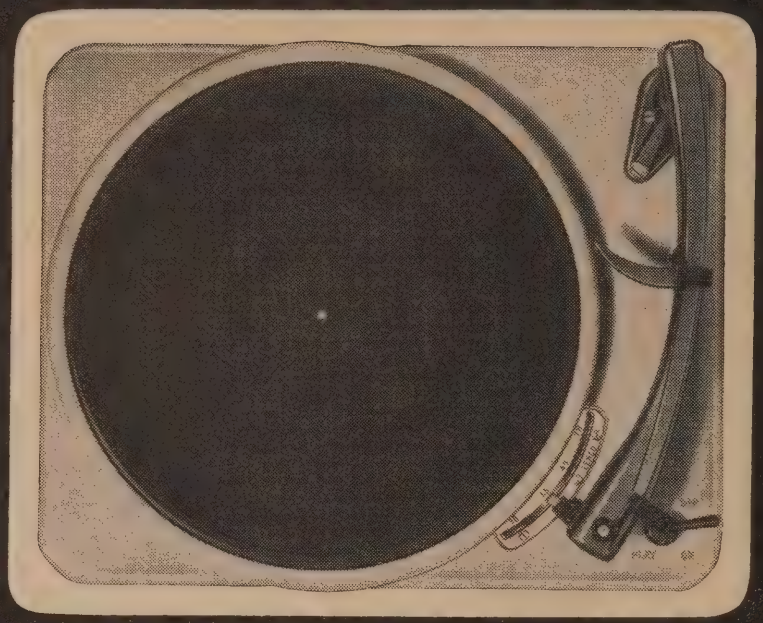
TCD40 this compact frequency divider with operating range from 1Mc/s to 40Mc/s can be used to extend the frequency range of any 1Mc/s or 10Mc/s timer counter to 40Mc/s by providing an additional divider stage.
Nett price in U.K. £110

ADVANCE ELECTRONICS LIMITED
INSTRUMENT DIVISION

SAI/11

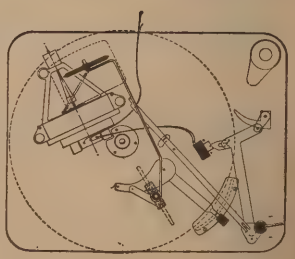
ROEBUCK ROAD, HAINAULT, ILFORD, ESSEX. TELEPHONE: HAINAULT 4444
9WW—022 FOR FURTHER DETAILS.

The shapes of sound



HI-FI ON A LOW BUDGET

The Goldring-Lenco GL 58 Transcription Unit is designed for those who want the best of both worlds—true high fidelity sound for a really low expenditure. The GL 58 gives them all they could wish for: a continuously-variable speed system with four adjustable click-in positions; a combined groove-selection and pick-up lowering device; an integral pick-up arm of proved performance; *and*, in addition, the GL 58 now has a new and even sturdier motor, Swiss precision engineered, and a reinforced centre spindle. All these outstanding features, coupled with its remarkably low price, make the GL 58 easily the finest value transcription unit on the Hi-Fi market.



GOLDRING-LENCO GL 58	£14-14-0 plus P.T. £2-7-9	A plinth mounted model (GL 58/P) is available at £17-4-0 plus P.T. £2-15-11

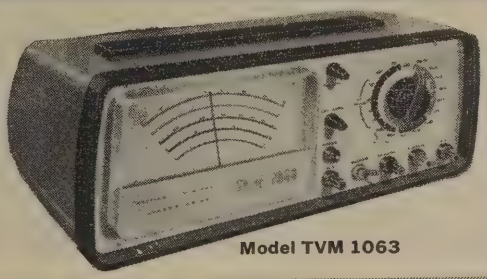
GOLDRING MANUFACTURING CO. (G.B.) LIMITED, 486-488 HIGH ROAD, LEYTONSTONE, LONDON, E.11. TELEPHONE: LEYTONSTONE 8341

9WW—023 FOR FURTHER DETAILS.

the significance of the BPL Transistorised Voltmeter is not only that it is portable, has an input impedance of 1MΩ/V and a lowest reading of 1×10^{-7} amps. but that this class of instrument can be made available for only £65

41 RANGES

d.c. voltage:	8 full-scale ranges 8 centre-zero ranges
d.c. current	6 full-scale ranges 6 centre-zero ranges
a.c. voltage: (10c/s-150kc/s)	6 ranges
r.f. voltage: (100kc/s-100Mc/s)	4 ranges
resistance:	3 ranges



Model TVM 1063

- Fully transistorised with internal batteries
- No warming up period – ready for instant use – no on/off switch
- Negligible zero drift
- Accuracy DC 3%, AC 4% f.s.d.
- Expanded arc Vistaview Meter with 5″ scale
- Zener stabilised reference voltage
- Electronic overload protection on all ranges
- Fibreglass cabinet

why not put it to the test

We invite you to compare its performance with that of any instrument you are using at present. We have models ready for immediate demonstration in your laboratory or workshop. A phone call will bring our technical representative round to see you. This does not entail any obligation on your part.

Why not give us a ring now?

see it at the IE&A EXHIBITION Stand N156

BRITISH PHYSICAL LABORATORIES · RADLETT · HERTS · RADLETT 4844

9WW—024 FOR FURTHER DETAILS.

Warning: ignitrons, thyratrons and motor-generator sets are now *obsolescent*—the IR 71RE series of epitaxial, high power, high voltage thyristors can do the same work cheaper, more reliably, and in a smaller space.

IR have developed an epitaxial process capable of producing 70-amp high power thyristors rated up to *1500 PRV* with controlled avalanche characteristics. There is no other high power thyristor with such advanced performance, nor will there be for a long time to come.

For facts which will make radical rethinking essential in the power control industry, contact IR at Oxted for details of the new 71RE series, and of the full range of IR thyristors —3-150 amps, 50-15-1500 PRV.

INTERNATIONAL RECTIFIER

IR

Immediate off-the-shelf delivery from IR distributors—phone

GLASGOW DOUGLAS 8671 · (MIDDLESEX) SKYPORT 1314 · COLCHESTER 6173 · LEEDS 35111
(LONDON S.E.27) GIPSY HILL 6166 · PORTSMOUTH 61785 · LEICESTER 25071 · CRAWLEY 28700

International Rectifier Europe S.A. · 38 Avenue Des Arts · Brussels · Belgium · Telephone 11.17.38/74 · Telex 02/22201

INTERNATIONAL RECTIFIER CO. (GREAT BRITAIN) LTD · HURST GREEN · OXTED · SURREY · TELEPHONE OXTED 3215 · TELEX RECTIFIER OXTED 8819

9WW—025 FOR FURTHER DETAILS.

WHARFEDALE SUPER/10/RS/DD

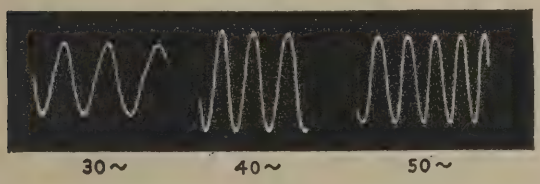
PRICE £10.18.8 (including 31/2 P.T.)

THE BEST 10" UNIT EVER PRODUCED BY WHARFEDALE

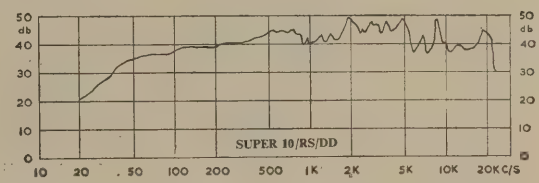
Impedance 10/15 ohms only. 1" dia. centre pole.
Flux density 16,000 oersteds.
Total Flux 85,000 maxwells.
Max. input 10 watts rms or 20 watts peak.
Frequency range 30-20,000 c/s.
Aluminium voice coil.
Roll Surround and double diaphragm.

PERFORMANCE

The wide frequency range covered by this speaker is indicated in the response curve. Excellent transient response is ensured by the high flux density and the double diaphragm assembly, which is mounted in a rigid die-cast chassis. The roll surround gives a clean note down to 30 c/s. with reasonable input and suitable enclosure.



Waveform with unit mounted in 4 cu. ft. cabinet with slotted back. Input 2 watts set at 1,000 c/s.



Axial response curve. Mic. distance 12" Input 4 v. at 1,000 c/s.

CABINETS

The Super 10/RS/DD performs well in a 2 cu. ft. reflex enclosure. The oscillograms show the output down to 30 c/s. in a 4 cu. ft. D.P. enclosure. Details of these and other cabinets for home construction are available in Leaflet CCS, Issue II.

APPLICATIONS

This speaker will do justice to any high quality amplifier in the 5/15 watts class. It will also improve results with reasonably good radio sets, tape recorders and record players. Although available only in 10/15 ohms, it can be used with impedance sources as low as 2/3 ohms without introducing distortion from mis-matching. (For maximum efficiency in such cases the W.M.T.I. matching transformer at 13/6 is recommended.)

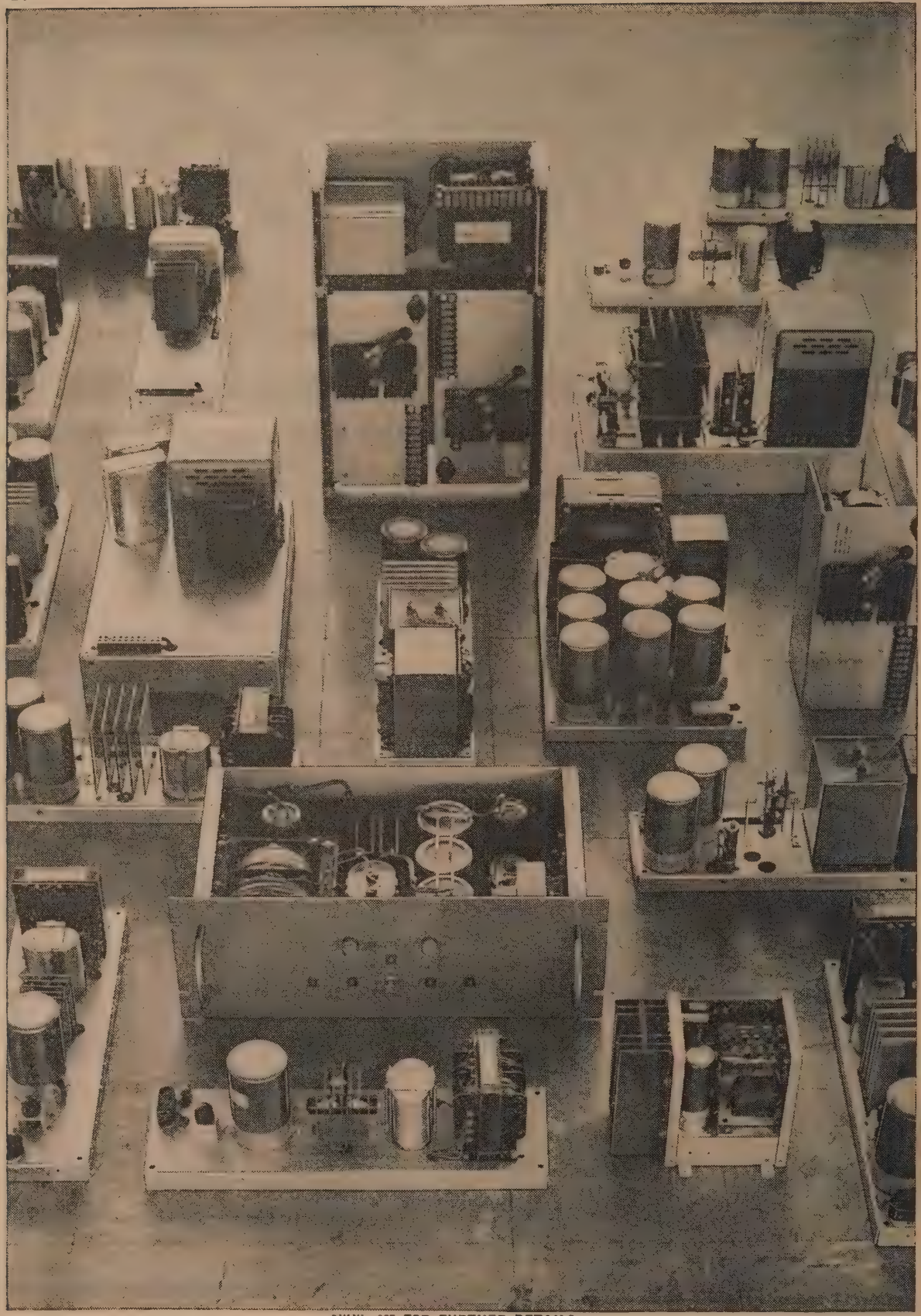
MADE AND GUARANTEED 12 MONTHS BY:—

Wharfedale

WHARFEDALE WIRELESS WORKS LTD
IDLE BRADFORD YORKSHIRE

TELEPHONE: IDLE 1235/6
TELEGRAMS: 'WHARFDEL' BRADFORD

9WW—026 FOR FURTHER DETAILS.



9WW—027 FOR FURTHER DETAILS.

FOR STABILISED D.C. POWER SUPPLIES CALL ADVANCE

Our standards are good—very good. If, for example, you need a reliable and stabilised d.c. supply from 6 to 50V you'll probably find just what you're looking for in our standard range of low-cost Equipment Power Supplies. Operating from 200 to 245V a.c. supplies (±15%) these units comprise a constant voltage transformer, silicon bridge rectifier and high capacitance filter, providing an adequate energy reservoir for apparatus with pulse, intermittent or variable loads. Add-on transistorised regulators are available for use on standard units DC 11—17 to achieve even greater stability and regulation.

Our standards are indeed good; our range—wide. But don't let them dictate your design. If yours is a special problem our engineers have both the know-how and the production capacity to solve it. So why not make contact? Write now for full details of our standard range or call up one of our technical representatives to discuss your problem.

TYPE	OUTPUT RATINGS		NETT PRICE IN U.K.
DC4	12V	4.00A	£27 0. 0.
DC6	24V	5.00A	£30 0. 0.
DC8	48V	4.00A	£32 0. 0.
DC11	6 or 6.5V	5.00A	£32 0. 0.
DC12	12 or 15V	5.00A	£33 0. 0.
DC13	24 or 28V	5.00A	£35 0. 0.
DC14	48 or 50V	5.00A	£38 0. 0.
DC15	12 or 15V	10.00A	£48 0. 0.
DC16	24 or 28V	10.00A	£54 0. 0.
DC17	48 or 50V	10.00A	£54 0. 0.
DCT1	5 to 30V	1.00A	£30 0. 0.
DCT2	25 to 50V	1.00A	£35 0. 0.

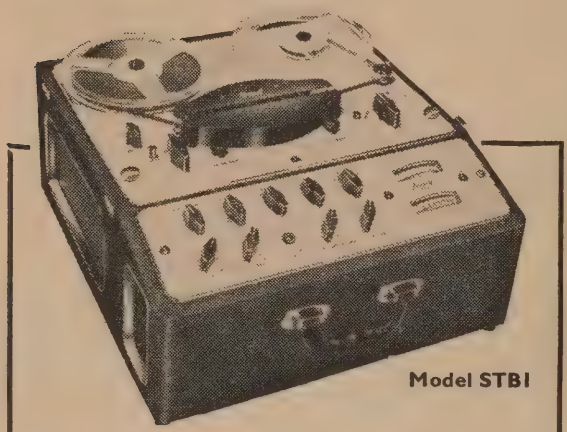
Advance

ADVANCE ELECTRONICS LIMITED
VOLSTAT DIVISION
ROEBUCK ROAD, HAINAULT, ILFORD, ESSEX, ENGLAND
TELEPHONE: HAINAULT 4444

SAV/8

9WW—028 FOR FURTHER DETAILS.

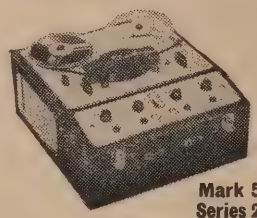
NO COMPROMISE ... for the best in Audio



Model STB1

Every link in the chain is as vital as the next when it comes to getting the best in High Fidelity and the tape recorder is no exception.
The Brenell range of three basic machines, which covers practically every requirement, has an enviable reputation for quality of performance, ease of operation, versatility and solid dependability.

Mark 5 Type M



Mark 5 Series 2

BASIC SPECIFICATION

(applicable to all 3 models)

4 speeds 1⅞, 3¾, 7½ and 15 i.p.s. · 3 independent motors (capstan drive-hysteresis synchronous) · interlocked controls · pause control · superimpose control 8¼″ reels · fast rewind (1200 ft. in 45 seconds).

Write for full details to the sole manufacturer:

Brenell

BRENELL ENGINEERING CO. LTD.
1a DOUGHTY STREET, LONDON, W.C.1.
Telephone: HOLborn 7356 (3 lines)

GD679

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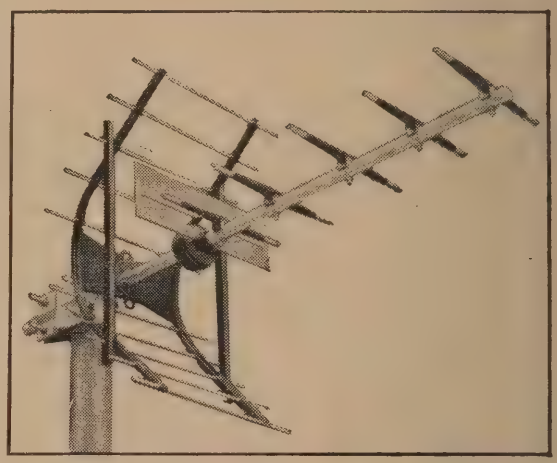
Fringevision Ltd

ELCOT LANE
MARLBOROUGH · WILTS

TELEPHONE **657** and **658**



WIDE BAND UHF AERIALS
for BBC2 now and ITV2

FIVE STAR QUALITY AERIALS

- ★ **Anodised elements for protection**
- ★ **Modern plastic moulding techniques used for convected reflector and parasitic elements giving longer life**
- ★ **Staggered spaced elements for maximum performance with all channel band width**
- ★ **Multi element reflector giving high back to front ratio**
- ★ **Maximum efficiency of matching by using laboratory developed collector plate—without any other matching device**

Model	Description	Gain	B/F Ratio	Retail Price
UF/H3	3-element. Head only with clamp	7.0 DB	18.0 DB	31/6
UF/H5	5-element. Head only with clamp	8.25DB	19.5 DB	36/6
UF/H7	7-element. Head only with clamp	10.5 DB	24.5 DB	41/–
UF/H10	10-element. Head only with clamp	12.5 DB	26.0 DB	47/–
UF/H12	12-element. Head only with clamp	13.5 DB	28.0 DB	51/–
UF/H14	14-element. Head only with clamp	15.0 DB	29.0 DB	55/–
UF/H18	18-element. Head only with clamp	16.25DB	30.0 DB	70/–
UF/H22	22-element. Head only with clamp	17.0 DB	31.0 DB	85/–

PLEASE STATE LARGE OR SMALL CLAMP REQUIRED.

9WW—030 FOR FURTHER DETAILS.

ADCOLA PRODUCTS LIMITED (Regd Trade Mark)

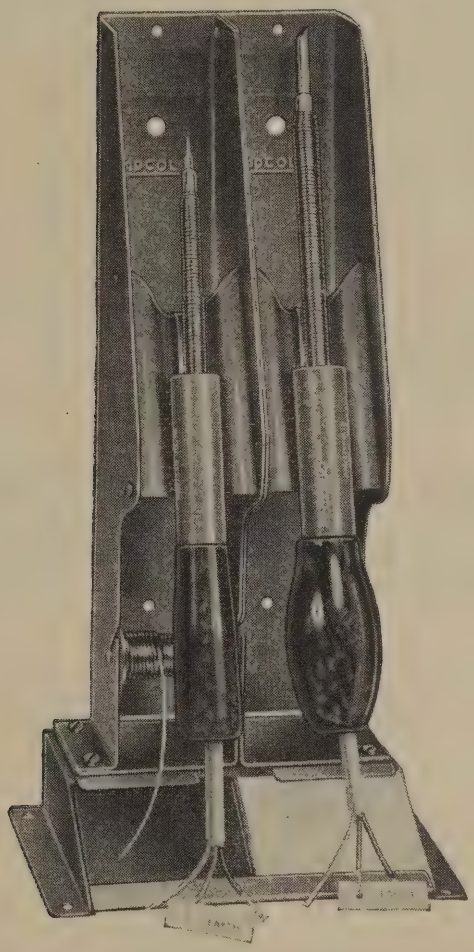
SOLDERING EQUIPMENT

TOTAL EFFICIENCY

FOR THE

SOLDER JOINTING INDUSTRY

COMPREHENSIVE VOLT RANGES



COMPREHENSIVE BIT SIZES

FOR CATALOGUES
APPLY DIRECT TO SALES & SERVICE DEPARTMENT

ADCOLA PRODUCTS LTD.
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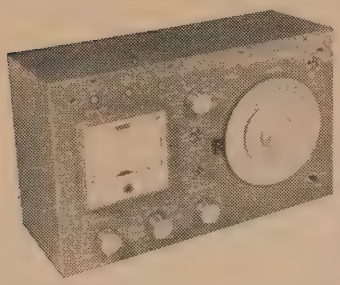
9WW—031 FOR FURTHER DETAILS.

RADFORD

AUDIO LABORATORY INSTRUMENTS



LOW DISTORTION OSCILLATOR

Basically an instrument of high stability, providing very pure sine waves directly without the use of filters in the range 5 c/s to 250 Kc/s.
The instrument is valve operated for sine wave generation, but semiconductors are used in a sine/square network to provide clean square waves from 5 c/s to 250 Kc/s. An accurate step attenuator (100 dB in 10 dB steps) is incorporated together with a 0-10 dB continuously variable attenuator which may be directly monitored on the built-in valve millivoltmeter. The millivoltmeter is a 4-stage feedback type with a very linear volt scale. It may be used for external measurement with a full scale deflection of 100 mV to 300 V. (8 ranges) with better than 1.0 dB accuracy over the range of the oscillator. The inherent distortion of the sine generator is lower than that of any other known instrument.

SPECIFICATION
Mains input: 110-140 v., 210-250 v., 50/60 c/s.
Output: 10 volts max. into 600 ohms.
Frequency range: Sine waves and square waves 5 c/s-250 Kc/s.
Sine wave distortion: 0.006%, 200 c/s-20 Kc/s.; increasing to 0.015% at 10 c/s. and 100 Kc/s.
Specification of included valve-millivoltmeter.
Input resistance: 1 Megohms.
Sensitivity: 100 mV-300 V. f.s.d. (8 ranges).
Response: ±1.0dB, 5 c/s.-250 Kc/s.
Price: £95.

DISTORTION MEASURING SET

An instrument capable of measuring total harmonic distortion speedily, accuratley, and directly on a calibrated meter scale without calculations or the use of ancillary balancing or rejection circuits. It is capable of reading a lower distortion level than any other known instrument or combination of instruments. It is all semiconductor operated, and is energised from an included 9 v. battery.

SPECIFICATION
Frequency range: 20 c/s-20 Kc/s (6 ranges).
Distortion range: 0.01%-100% f.s.d. (9 ranges).
Sensitivity: 100 mV-100 V. (0.01% and 0.03% f.s.d. ranges operate above 1 volt inputs).
Meter: Square law r.m.s. reading.
Input resistance: 200K ohms.
High pass filter 3 dB down at 500 c/s; 30 dB down at 50 c/s.
Harmonic response: ±1 dB 2nd harmonic to 250 Kc/s.
Price: £75.

Leaflets outlining the principles of design, with exact details and complete specification, are available on request.

RADFORD ELECTRONICS LTD. Ashton Vale Estate · Bristol, 3, England. *Tel:* 662301-2.

9WW—032 FOR FURTHER DETAILS.

FANE HIGH FIDELITY LOUDSPEAKERS

Full Range of Heavy Duty Types for All Purposes

CAST ALUMINIUM CHASSIS. EXTREMELY ROBUST 2in. DIAMETER VOICE COIL ASSEMBLIES

Model	Cone	Frequency response c.p.s.	Impedance ohms	Main resonance c.p.s.	Power handling watts R.M.S.	Flux density gauss	Total flux Maxwells	Voice coil winding	Diam. of Chassis	Baffle Hole	Net weight lbs.	Retail Price
122/10	Single	25-5000	15	32 or 75	20	10,000	100,000	Copper	12in.	11in.	6lbs.	5 gns.
122/10A	Dual	10-15000	15	32 or 75	20	10,000	100,000	Aluminium	12in.	11in.	6lbs.	6 gns.
122/12	Single	25-5000	15	32 or 75	20	12,000	160,000	Copper	12in.	11in.	6lbs.	7 gns.
122/12A	Dual	30-15000	15	32 or 75	20	12,000	160,000	Aluminium	12in.	11in.	6lbs.	8 gns.
122/14	Single	25-5000	15	32 or 75	22	14,000	186,000	Copper	12in.	11in.	7lbs.	9 gns.
122/14A	Dual	30-15000	15	32 or 75	22	14,000	186,000	Aluminium	12in.	11in.	7lbs.	10 gns.
122/17	Single	25-6000	15	32 or 75	25	17,000	226,000	Copper	12in.	11in.	10½lbs.	£11/17/6
122/17A	Dual	30-17000	15	32 or 75	25	17,000	226,000	Aluminium	12in.	11in.	10½lbs.	£12/17/6
152/12	Single	25-3500	15	30 or 75	20	12,000	160,000	Copper	15in.	13¼in.	8lbs.	12 gns.
152/12A	Dual	30-15000	15	30 or 75	20	12,000	160,000	Aluminium	15in.	13¼in.	8lbs.	13 gns.
152/14	Single	25-3500	15	30 or 75	22	14,000	186,000	Copper	15in.	13¼in.	9lbs.	14 gns.
152/14A	Dual	30-15000	15	30 or 75	22	14,000	186,000	Aluminium	15in.	13¼in.	9lbs.	15 gns.
152/17	Single	25-4000	15	30 or 75	25	17,000	226,000	Copper	15in.	13¼in.	12¼lbs.	16 gns.
152/17A	Dual	30-17000	15	30 or 75	25	17,000	226,000	Aluminium	15in.	13¼in.	12¼lbs.	17 gns.

EXTRA HEAVY DUTY TYPES WITH 3in. DIAMETER POLE PIECES

153	Single	30-3500	15	40 or 75	40	14,000	375,000	Copper	15in.	13¼in.	20lbs.	18 gns.
183	Single	20-3000	15	30 or 75	60	14,000	375,000	Copper	18in.	16½in.	22lbs.	25 gns.

AVAILABLE THROUGH ALL SOUND EQUIPMENT STOCKISTS

Manufacturers' enquiries to:
FANE ACOUSTICS LTD.
HICK LANE : BATLEY, YORKS.

Sole distributors to Wholesale and Retail Trade:
LINEAR PRODUCTS LTD.
ELECTRON WORKS : ARMLEY, LEEDS

9WW—033 FOR FURTHER DETAILS.

IF

YOU KNOW ANYONE WHO CAN DELIVER

QUICKER

!!! READ NO FURTHER !!!

We've yet to hear of a company that meets orders faster than Newmarket Transistors Ltd. As transistor specialists we make a point of having our complete NKT 400 power and NKT 300 Intermediate power range in stock, to meet your immediate requirements. Really big orders require time, naturally — but not as much as you might think. Try us, and see.

NKT	CAR RADIO	DC VOLTAGE REGULATOR	DC CONVERTER	P/P AMP (TRANSFORMERED)	P/P AMP (TRANSFORMERLESS
6V	362 452	303 402	304 405	303 451	304 405
12V	361 453	304 405	303 402	304 404	304 404
24V		302 403	301 401	302 403	304 404
48V		301 401			302 403

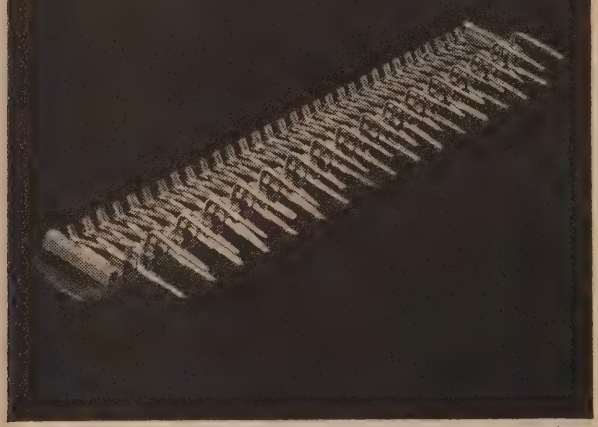
Data sheets for all types from NEWMARKET TRANSISTORS LTD, (P.T.B) EXNING ROAD, NEWMARKET. Tel: Newmarket 3381

DENMARK: Oskar Pade, 4 Ingersvej, Charlottenlund, Copenhagen. FINLAND: Insinooritoimisto Pluton, Kirstinkatu, 8A Helsinki 12.
SWEDEN: Forslid & Co. A B., Radmansgatan 56, Stockholm. NORWAY: Sigurd Feiring, Lilletorvet, 1, Oslo.

9WW—034 FOR FURTHER DETAILS.

'Standard' Series

laminated
edge connectors



30/2

Cinch "Standard" Series laminated edge connectors for ·062" printed circuits with ·150" and ·156" contact pitch offer designers many advantages. Any number of ways from 1 to 40 — Low cost — Easy, quick assembly — No moisture traps — Positive operation with maximum and minimum board thicknesses — Ribbed contacts — Various contact tail styles for solder and solderless termination. With their complementary "Point 1" and "332" Series, Cinch laminated edge connectors offer the most comprehensive and versatile range of designs available.

SPECIFICATION

Current Rating	— 5 amps per contact
Working Voltage	— 500V D.C.
Proof Voltage	— 2 KV D.C.
Contact Resistance	— 5mΩ

CARR FASTENER CO LTD

the firm with the best connections

TRADE Cinch MARK

Stapleford, Nottingham · Tel: Sandiacre 2661
York House, Empire Way, Wembley, Middx. Tel. DILigence 1255/9
Crossford Court, Dane Rd, Sale, Cheshire. Telephone Sale 4213/4

9WW—035 FOR FURTHER DETAILS.

TOROIDAL POWER TRANSFORMERS

HEAVY DUTY
TOTALLY ENCLOSED
COMPOUND FILLED
LOW MAGNETIC FIELD

- **AUTO-Transformer 1000 Watt**
  200 - 250 to 100/115/150 volts
  Price £8. 10. 0d.

- **ISOLATING-Transformer 400 Watt**
  200 - 250 to 115/230 volts
  Price £9. 5. 0d.

- **LOW VOLTAGE-Transformer 400 Watt**
  200-250 to 25/50 volts
  Intrinsically safe: series parallel
  L.T. windings: wall or floor mounting
  Price £8. 19. 0d.

All types:	$7\frac{1}{16}$" x $7\frac{3}{8}$" x $2\frac{7}{8}$" overall
cable entry:	Grommet or conduit
Weight:	ONLY 14 lbs.
Delivery:	Ex. Stock.

Trade & Export enquiries invited.
Quotations for non-standard items in quantity made by

AVEL PRODUCTS LTD.

distributed by.

AVELEY ELECTRIC LTD
SOUTH OCKENDON ESSEX
TELEPHONE SOUTH OCKENDON 3444
TELEX 24120 AVEL OCKENDON

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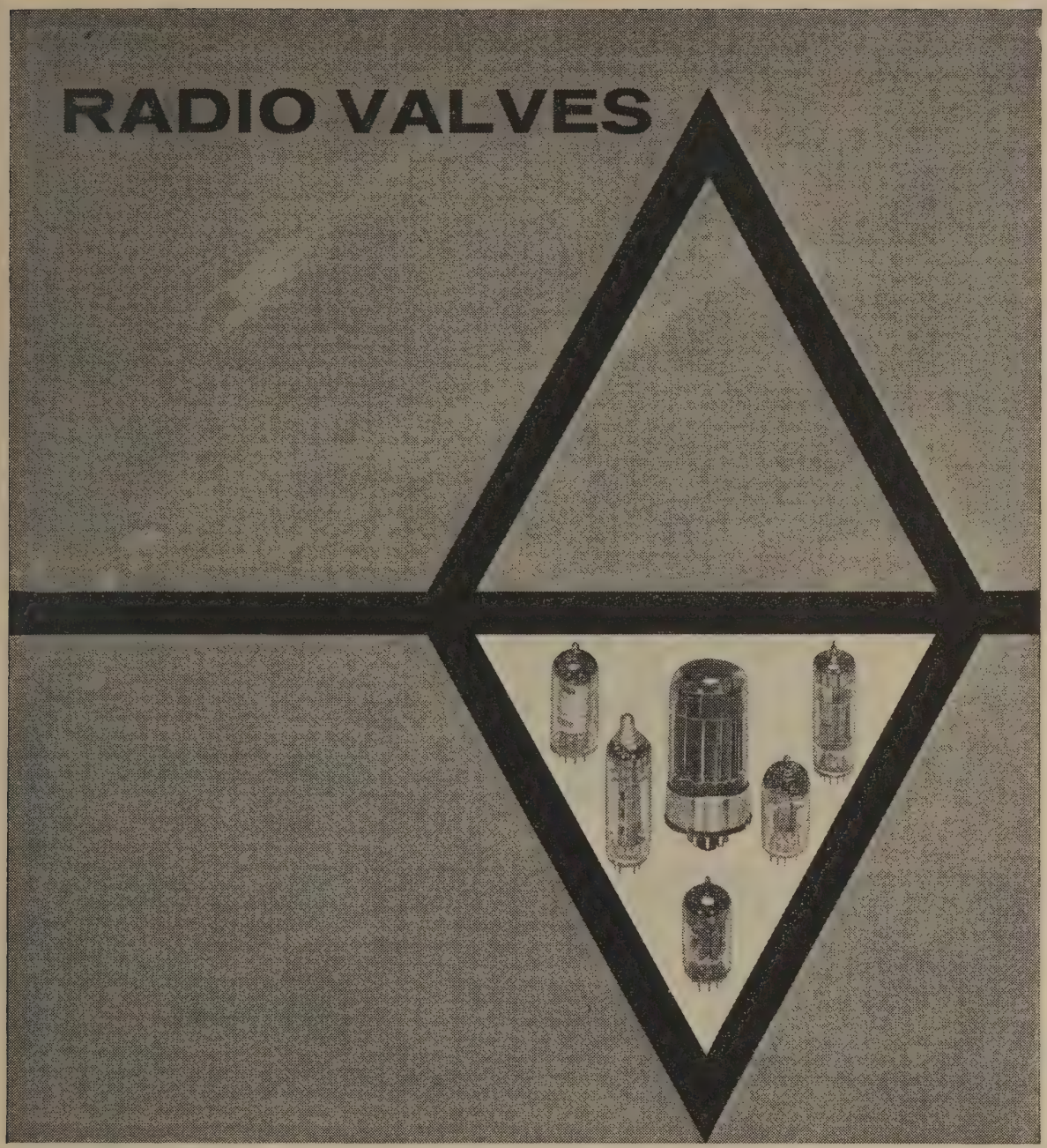
RADIO VALVES



HALTRON offers you the most comprehensive stock in the world. 3,000 types of receiving, special purpose, transmitting tubes and transistors available at short notice. A permanent stock of 4,000,000 tubes always ready for prompt despatch. Comprehensive export price list is available at your request.

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HALL ELECTRIC LIMITED

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MARCONI INSTRUMENTS PRESENT-

The World's First SOLID

NEW solid state circuit techniques enable complete range, 10 kc/s—72 Mc/s, to be covered in 8 bands.

NEW r.f. generating system uses separate oscillator and output circuit for each band, ensuring best performances throughout frequency range.

NEW high discrimination tuning. Exceptionally low leakage and spurious modulation.

NEW zig-zag tuning system cuts tedium and speeds up tuning at extremes of frequency bands.

NEW three-frequency crystal calibrator with 1 kc/s filter for accurate bandwidth measurements and for standardising incremental tuning scale.

NEW continuously variable internal oscillator provides up to 100% A.M. over entire AF range 20 c/s to 20 kc/s.

NEW unitised construction techniques and compact dimensions.

Please write or telephone for full technical information. Address your enquiries to **Marconi Instruments Limited** at your nearest office.

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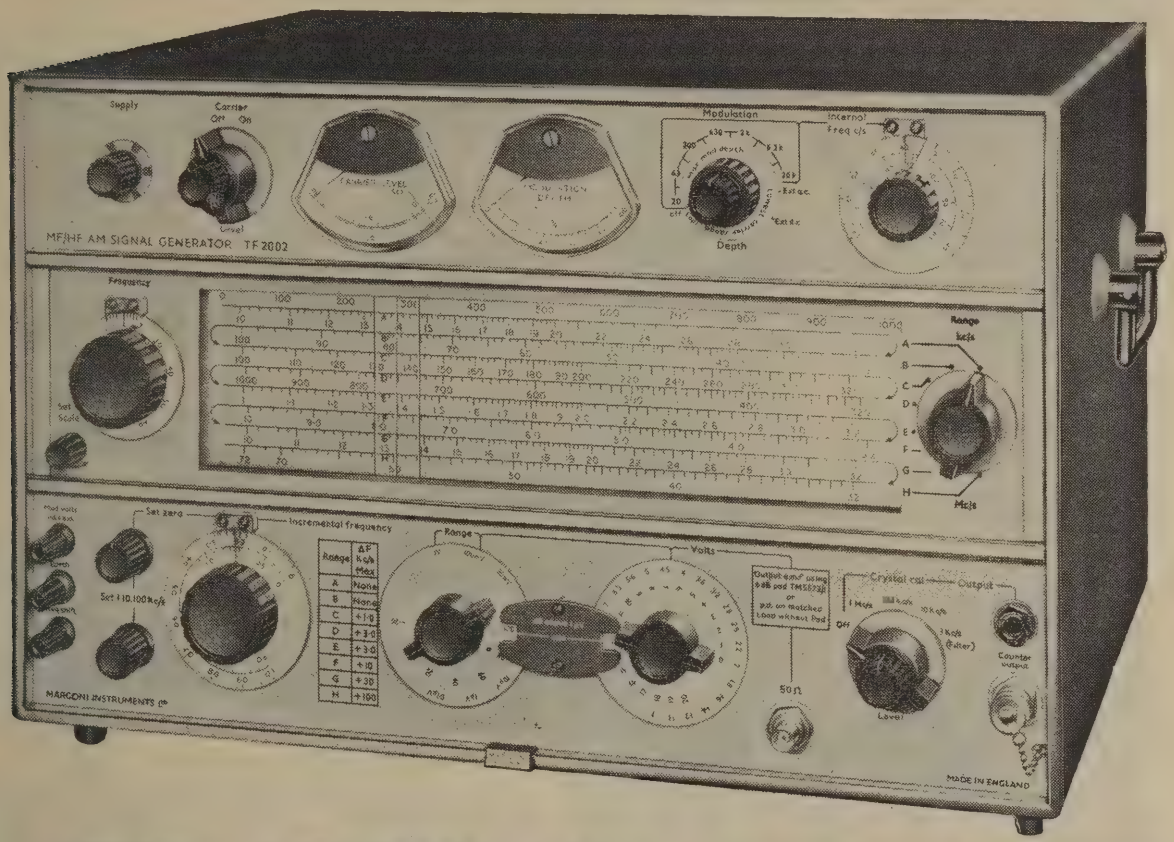
Type TF 2002

RACK-MOUNTING VERSION AVAILABLE



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MF/HF SIGNAL GENERATOR

See the NEW 2000 Series on Stand No. N.189 National Hall at the I.E.A. Exhibition, May 25th–30th.

A GOOD NAME FOR GOOD MEASURE

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Head Office—Home and Export Sales:
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MARCONI INSTRUMENTS

TC156

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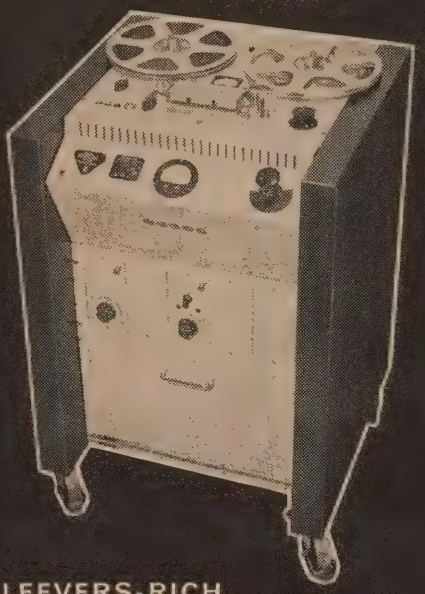
SAVE TIME SPACE COST



LEEVERS-RICH
the studio tape recorder with consistent operation and easy maintenance to save your TIME; compact design and mobility to save your floor SPACE; competitive price and negligible upkeep to lower your COSTS. These down-to-earth practical features AND the impeccable LEEVERS-RICH sound quality.

STANDARD studio recorder console (above) with FULL remote control. Single track from £640.0.0. Just one example from a complete range of portable, console and rack-mounted recorders for single or multi-track use, including the NEW fully automatic version with photo-electric programming system.
DELIVERY—sooner than you expect for this class of equipment! Inquire NOW:—

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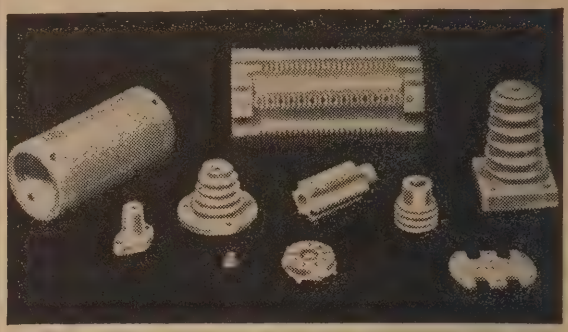
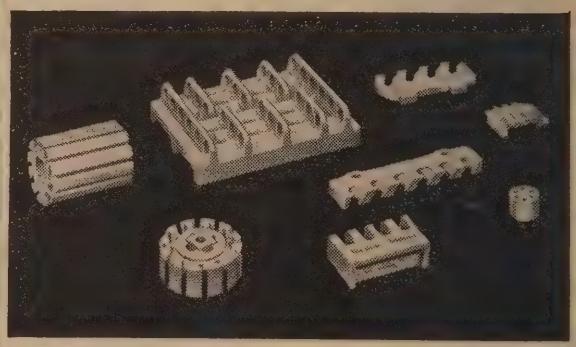
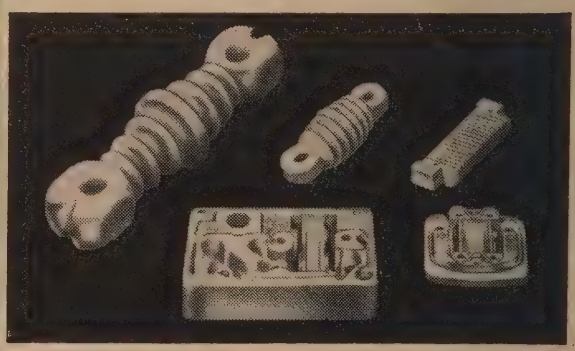
Bullers CERAMICS
for the ELECTRONIC INDUSTRY
(and Electrical Appliance Manufacture)



Frequelex—for high-frequency insulation.



Refractories for high-temperature insulation.



Bullers porcelain for general insulation purposes.

Meticulous care in manufacture, high quality material, with particular attention applied to *dimensional precision and accuracy*, explain the efficiency and ease of assembly when using Bullers die pressed products. *Write today for detailed particulars.*

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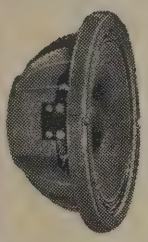
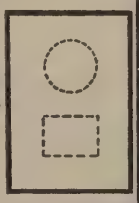
GOODMANS COMPACT TRUE HIGH FIDELITY DESIGNED FOR MODERN LIVING



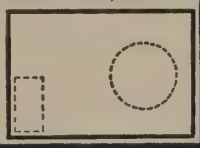
AXIETTE 8 (8 inch—6 watt—15 ohm)

Frequency range.....40-15,000 c/s
For amplifiers up to.....6 watts (12 watts U.S.A.)
Fundamental resonance.....65 c/s
Flux density.....13,500 gauss
Overall depth.....3⅜"
Reflex Enclosure volume 3,000 cu. ins.
PRICE £4. 11. 0. (+ 14/7d. P.T.)



AXIOM 10 (10 inch-10 watt-15 ohm)

Frequency range.....40-15,000 c/s
For amplifiers up to.....10 watts (20 watts U.S.A.)
Fundamental resonance.....45 c/s
Flux density.....13,500 gauss
Overall depth.....4 5/16"
Reflex Enclosure volume.....5,000 cu. ins.
PRICE £5. 8. 6.
(+ 17/5d. P.T.)



GOODMANS

GOODMANS INDUSTRIES LIMITED
Axiom Works, Wembley, Middlesex, England.
Tel: WEMbley 1200
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High Fidelity listening is one of the pleasures of modern living. And you can enjoy true High Fidelity by choosing Goodmans full range High Fidelity loudspeakers.

Goodmans AXIETTE 8 and AXIOM 10 have unique design features, provide outstanding performance and can be correctly housed unobtrusively and compactly.

The Axiette 8 is for use with amplifiers up to 6 watts of power rating; the Axiom 10 handles up to 10 watts—a choice that is more than adequate for most domestic installations. And they take up so little space. The enclosures for both the Axiette 8 and the Axiom 10 are of modest dimensions—full details of enclosures designs are given in Goodmans High Fidelity Manual, send the coupon below for your free copy.

For a really compact complete High Fidelity loudspeaker system, consider the 8 watt MAXIM—the outstanding success of the recent Audio Festival—or the slim, 15 watt Eleganzia II

MAXIM.
The smallest ever! Only 10½" x 5½" x 7½" deep—no bigger than two stout books. Gives true full range High Fidelity, 45-20,000 c/s. Up to 8 watts. 15/16 ohms.
£15.0.0. + P.T. £2.10.6.

ELEGANZIA II
Elegant and super slim — 27" x 20" x 6½" deep. Outstanding High Fidelity performance over a range of 35 - 15,000 c/s. Up to 15 watts 15/16 ohms.
£27. 10. 0.

Made your choice? Confirm it. Hear the true High Fidelity of your selection at your Goodmans dealer.

Please send me a free copy of the Goodmans High Fidelity Manual.
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WW6
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MECHANICAL RELAY LATCH FOR P. O. TYPE 3000

This latching device enables the P.O. 3000 type relay to be held in the closed position when the coil is de-energised and until manually released.
Does not impair the versatility of the contact arrangements, nor affect the normal mounting position.

WILL TRIP AND HOLD ON A.C. OR D.C. IMPULSE

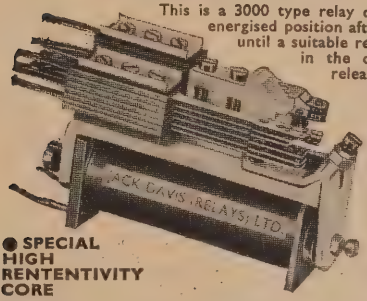
Please send for illustrated leaflet.

Illustrations show 3000 Type Relay fitted with "Remote" and "Local" release latch.

EITHER TYPE CAN BE FITTED TO YOUR EXISTING 3000 TYPE RELAYS IN A MATTER OF MINUTES

STANDARD 3000 TYPE RELAYS
BUILT TO SPECIFICATION
Quotations by Return of Post. Prototypes within 48 hours.

THE "REMANENCE" RELAY



This is a 3000 type relay capable of latching in the energised position after the supply is removed, until a suitable releasing current is applied in the opposite direction. This releasing current is controlled by two methods:—

1. With a single coil, by reducing the operating current in reverse.
2. Witb a double coil, via a pair of contacts employed on the relay to energise the second coil.

Information on any contact arrangement to be employed can be obtained on application.

● SPECIAL HIGH RENTENTIVITY CORE

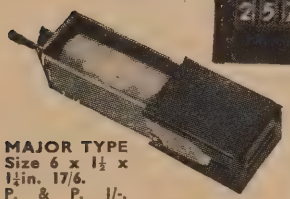
Ministry of Aviation Approved Inspection EID

● RELAYS Type 600 ● Polarised ● AC Relays ● High Speed ● Uniselectors ● Latching Relays ● Magnetic Counters ● Miniature Sealed Relays. Available from stock or supplied to specification.

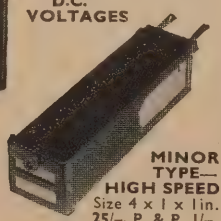
ELECTRO-MAGNETIC COUNTERS

TESTED AND GUARANTEED.

FOR ALL D.C. VOLTAGES



MAJOR TYPE Size 6 x 1½ x 1¼in. 17/6. P. & P. 1/-.



MINOR TYPE— HIGH SPEED Size 4 x 1 x 1in. 25/-. P. & P. 1/-.

Jack Davis (Relays) Ltd.

Dept. "W," 9/10, MALLOW STREET, OLD STREET, LONDON, E.C.1 Tel. CLErkenwell 3661/2

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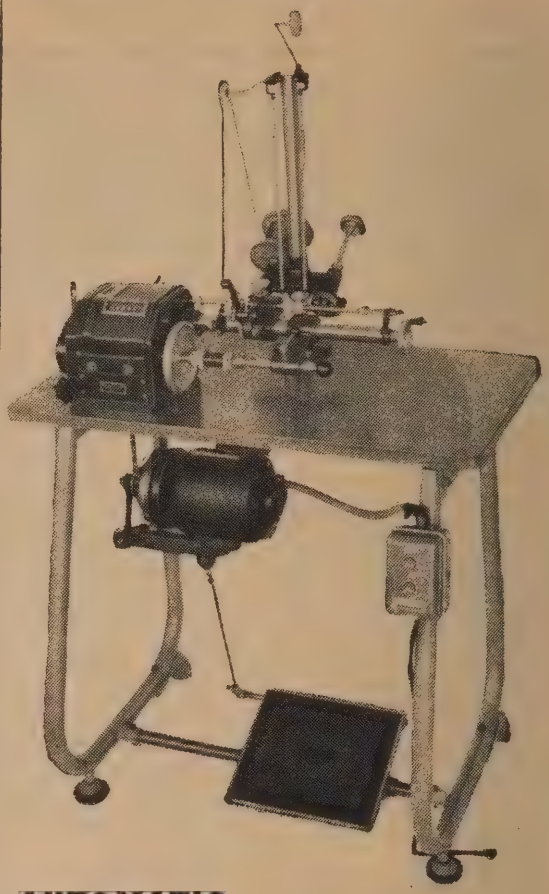
Kolectric present their



AUTOMATIC COIL WINDING MACHINE

Type A/11 (25-50 S.W.G.)
Type A/IX (19-46 S.W.G.)

incorporating ALL these refinements:

★ Dustproof construction

★ Provision for simultaneous winding of several coils

★ Micrometer traverse setting

★ Wire gauge indicator engraved with various settings to which machine can quickly be adjusted

★ Instantaneous re-set turns counter reading up to 100,000 turns.

★ Efficient wire tensioning stand supporting two reels of wire

★ Cadmium- or chromium-plated steel parts

A fully illustrated leaflet quoting complete technical specifications is available. We will be pleased to send it to you on request.

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DOUBLE IMAGE

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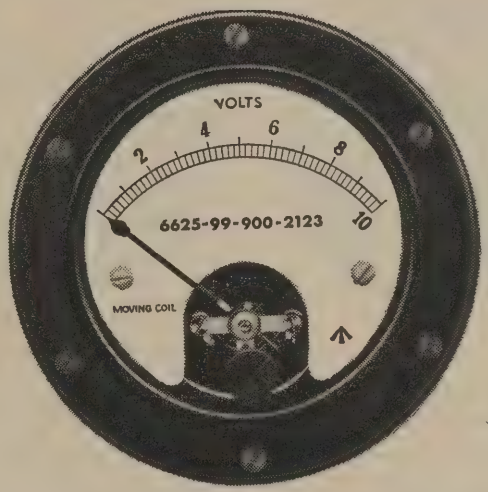
The image of Ernest Turner Electrical Instruments is, we are proud to say, one of Quality—both in the instruments we manufacture and in our methods of doing business. The name Ernest Turner conjures up visions of nimble-fingered craftsmen, exhaustive testing, rigid inspection and, not the least, an attitude of full co-operation with the customer and a genuine wish to satisfy his special requirements, whether the need is for a single meter or a thousand.

Naturally, things being what they are, there must be a snag somewhere—a misty part of the image so to speak. To date, the unsharp part of our Image has been Long Delivery. Because of the care and accurate workmanship demanded of our staff, the "big whip" is mostly kept in the cupboard, even when the order book is overflowing. As a result, many potential users of the World's Finest Instruments have been offered a delivery time too long for their production schedules.

This part of our image we can now bring into sharp focus. Our production capacity has been steadily increased during the past twelve months, so that our delivery times are now fully competitive. Moving coil meters can be supplied in 6-8 weeks, and moving iron and electrostatic types in 8-10 weeks. Our service remains as good as ever—special scale markings, choice of pointer shapes, mirror scales on certain models, and development of movements for specific purposes.

So the "double image" of Ernest Turner becomes a single image—highest quality with speedy delivery.

The Ernest Turner page



We make no apology for giving regular readers a second look at our Model 25HS, which has recently been approved to Specification DEF.62. This is the first, and as far as we know, the only measuring instrument to comply with this specification.

Tests are in progress with a view to obtaining similar approval for the other two instruments in our HS range; we shall then be able to offer 2in., 2½in. and 3½in. meters with a unique combination of features which make them suitable for use under the most rigorous conditions.

With full approval for the HS range, the wheel will have turned full circle. The specification known as RCS 231/RCL 231, published by H.M. Stationery Office, was originally written around this Ernest Turner design, and now that DEF.62 approval has been granted, RCS 231/RCL 231 will be obsolete.

ERNEST TURNER
ELECTRICAL INSTRUMENTS LTD

CHILTERN WORKS · HIGH WYCOMBE
BUCKINGHAMSHIRE · ENGLAND
Tel: High Wycombe 1301

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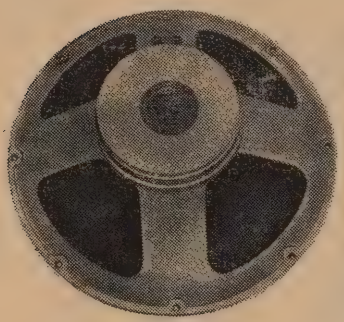
2 NEW FANE HIGH POWER LOUDSPEAKERS

15″ Model 153
40 watts **£18.18.0**



18″ Model 183
60 watts **£25.4.0**

These extra heavy duty speakers have 3″ voice coils and 14,500 gauss magnets with a total of 375,000 maxwells.

These two models have very large ceramic-type magnet systems with 3in. diameter pole pieces. They are built with massive cast aluminium chassis and are ideal for high power applications such as the Electric Organ, Bass Guitar, or the bass unit in a large Hi-Fi system.

Manufacturers enquiries direct to

FANE acoustics LIMITED

HICK LANE
BATLEY YORKSHIRE

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Sole distributors to the wholesale and retail trade:—
LINEAR PRODUCTS LIMITED, ELECTRON WORKS, ARMLEY, LEEDS 12.

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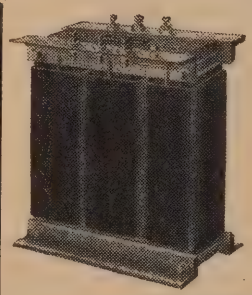


1 PHASE AND 3 PHASE

0.5 KVA TO 250 KVA

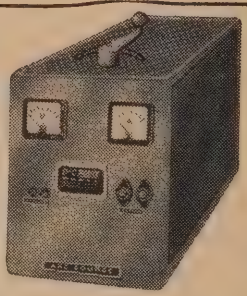
TRANSFORMERS

RECTIFIER SETS

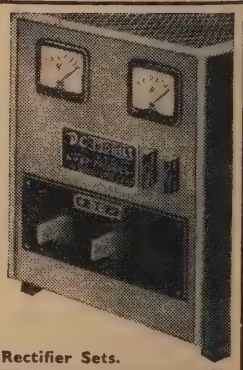
100 W 150 kW
FIXED OR VARIABLE OUTPUT
1 PHASE & 3 PHASE

Electro-Plating, Plasma, Arc Welding, Electro-Magnets, Carbon Arc, Battery Charging and other uses.

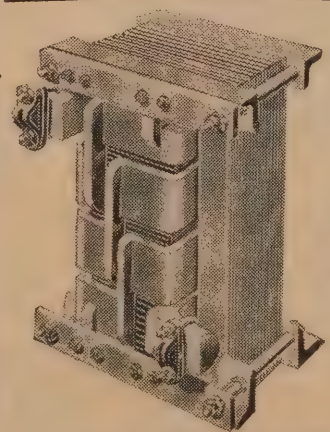
Plasma Arc Sets and other specialized equipment for gas, vacuum and powder techniques. Power Control by saturable reactors and other methods.



Variable Output D.C. Sources



Low Voltage High Current Rectifier Sets.



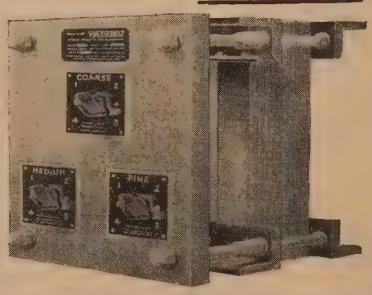
HIGH CURRENT TRANSFORMERS

1 Phase and 3 Phase

Output currents of hundreds or thousands of amperes for Furnaces, Rectifier Sets, Heat Runs, Short Circuit Testing and other uses.

Examples: 5V300A,
10V1,000A,
20V3,000A,
5V6,000A.

VOLTMOBILE



64 STEP ON LOAD SWITCHING AUTO-TRANSFORMERS

Output 1.6% to 100% or 125% of input volts in 64 steps or 80 steps. A control device for many loads—resistance furnaces, rectifier sets, battery charging, anodising, heating and other uses. 1 Phase and 3 Phase. 18 Models.

Output currents from 20 A to 200 A.

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Telephone: Todmorden 602

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New Study Programmes

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- **Servo Systems**
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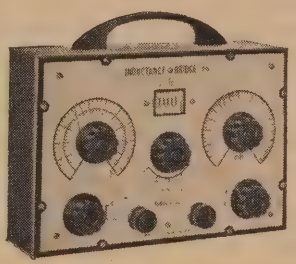

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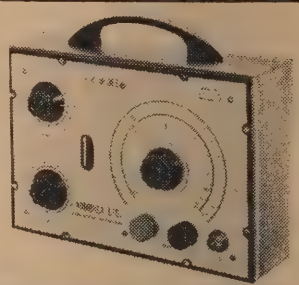

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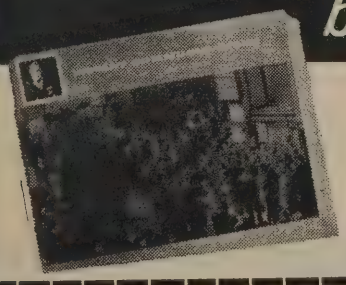

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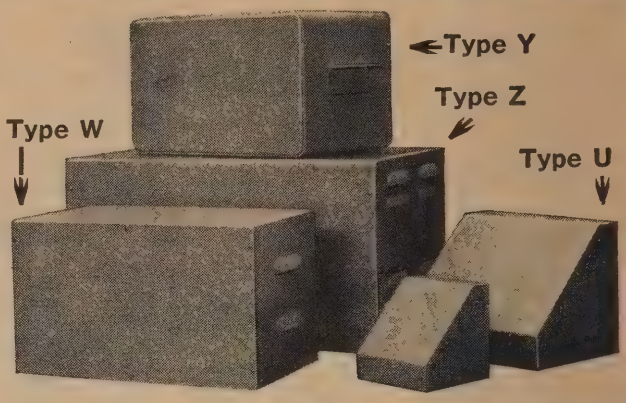

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U	8 x 6 x 6	20/–	Y	13 x 7 x 9	44/–
U	15 x 9 x 9	42/6	Y	15 x 9 x 7	46/–
W	8 x 6 x 6	19/6	Z	17 x 10 x 9	63/–
W	12 x 7 x 7	32/6	Z	19 x 10 x 8½	67/6
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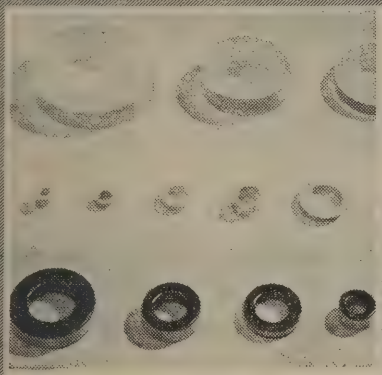

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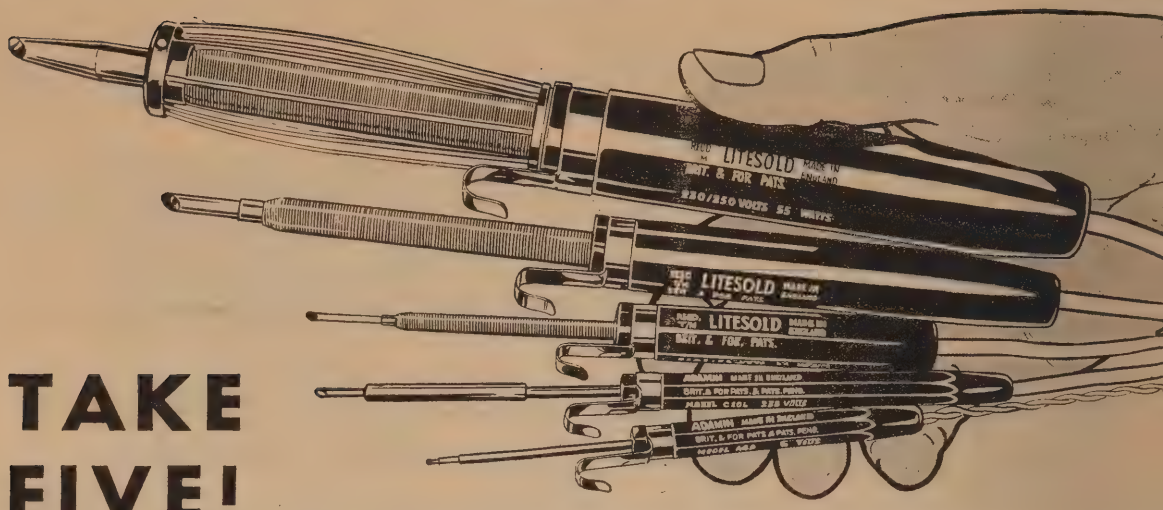

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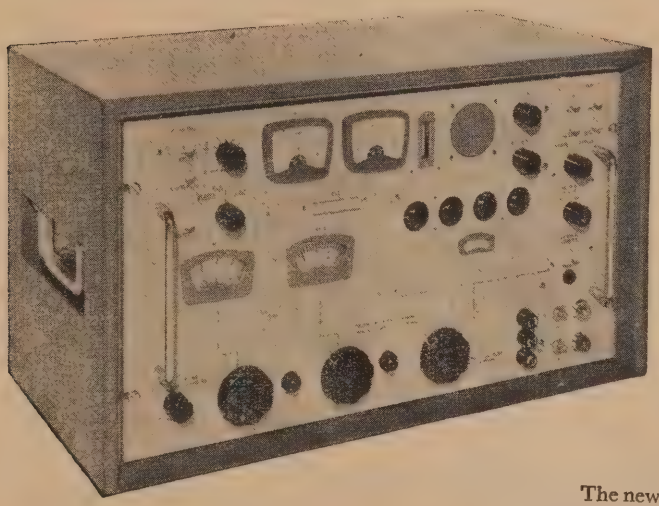

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TR6 (NJ65)	RO3-D	¼	1%	68 Ohms–470K
TR5 (CJ20)	RO2-C	½	5%	22 Ohms–470K
TR6 (CJ32)	RO2-B	1	5%	33 Ohms–1 Megohm

Electrosil LIMITED PALLION, SUNDERLAND, CO. DURHAM *Tel: Sunderland 71557 · Telex 53273*

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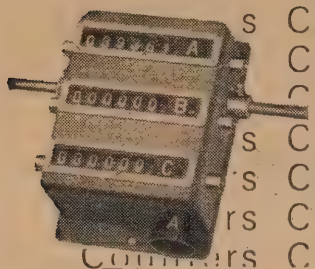

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Mechanical

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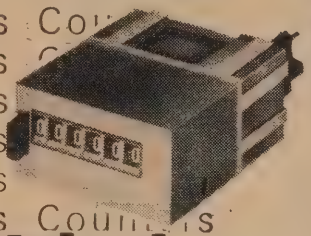

Electrical

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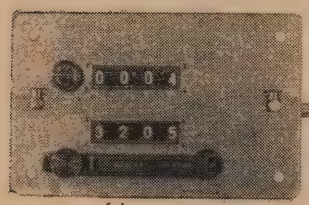

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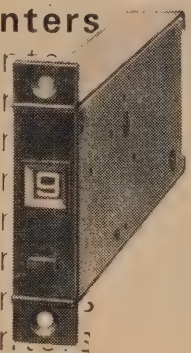

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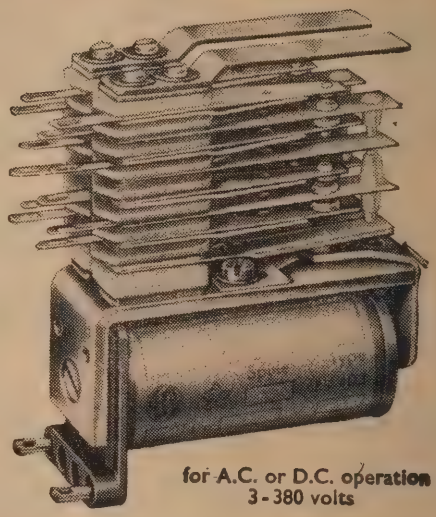

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DC Control Current FC11	0-15mA
FC12	0-5mA

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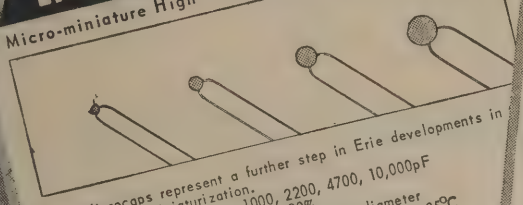
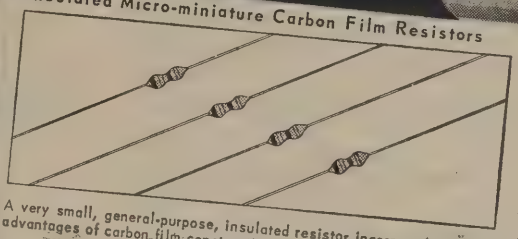
Micro-miniature High Value Disc Ceramicons*



Erie Microcaps represent a further step in Erie developments in field of micro-miniaturization.
Capacitance : 1000, 2200, 4700, 10,000pF
Tolerance : +80, –20%
Dimensions : 0.08in to 0.20in diameter
Working Volts : 30d.c. at from –40°C to +85°C
Power Factor : 3% max.
Dielectric : K7004
Write for 'Microcap' literature

ERIE EMO

Insulated Micro-miniature Carbon Film Resistors



A very small, general-purpose, insulated resistor incorporating all the advantages of carbon film construction.
Resistance Range : 10Ω to 150,000Ω
Tolerance : ±2%, ±5%, ±10%
Voltage Rating : 70V d.c. max.
Wattage Rating : 1/20W at 70°C
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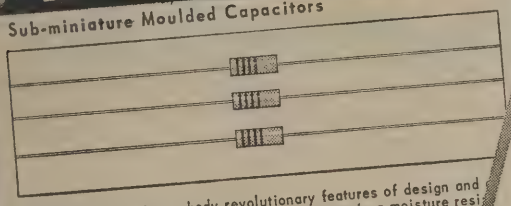
ERIE 390

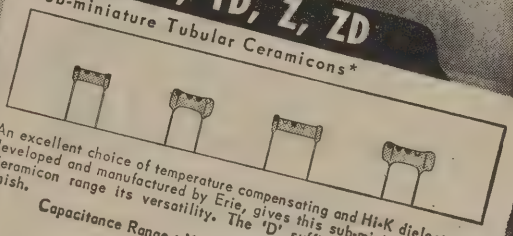
Sub-miniature Moulded Capacitors



Erie Style 390 units embody revolutionary features of design and construction to attain a wide range of capacitance in a moisture resistant moulding. Style 390 meets or exceeds requirements of MIL-C;
Capacitance : 5.6 to 1200pF
Tolerance : ±10% to +80, –20%
Working Volts : 100d.c. at +85°C
50d.c. at +125°C
Write for 'Style 390' literature

ERIE Y, YD, Z, ZD

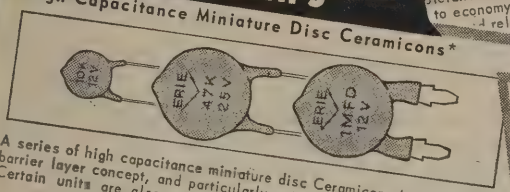
Sub-miniature Tubular Ceramicons*



An excellent choice of temperature compensating and Hi-K dielectrics, developed and manufactured by Erie, gives this sub-miniature tubular Ceramicon range its versatility. The 'D' suffix indicates insulated finish.
Capacitance Range : Y, YD–2pF to 1000pF
Z, ZD–8pF to 1500pF
Tolerance : ±5%, ±10%, ±20% and –20% +50% according to dielectric
Working Voltage : 150V d.c. at from –40°C to +85°C
Dielectric : P100 to Hi-K
Write for Y, YD, Z and ZD literature

ERIE TRANSCAPS*

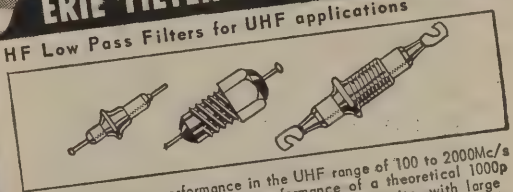
High Capacitance Miniature Disc Ceramicons*



A series of high capacitance miniature disc Ceramicons based on the barrier layer concept, and particularly suited for transistor circuitry. Certain units are also available with Erie Pluggable terminations.
Capacitance Range : 0.01pF to 0.5pF according to style
Tolerance : –25%, +50%
Working Voltage : 3V, 6V, 12V or 25V d.c. according to style
Operating Temp : –40°C to +85°C
Write for 'Transcap' literature

ERIE FILTERCONS*

HF Low Pass Filters for UHF applications



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50dB, 100 to 2000Mc/s
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Working Volts : 200, 350 or 500d.c.
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Write for 'Filtercon' literature

ERIE ELECTRONIC COMPONENTS

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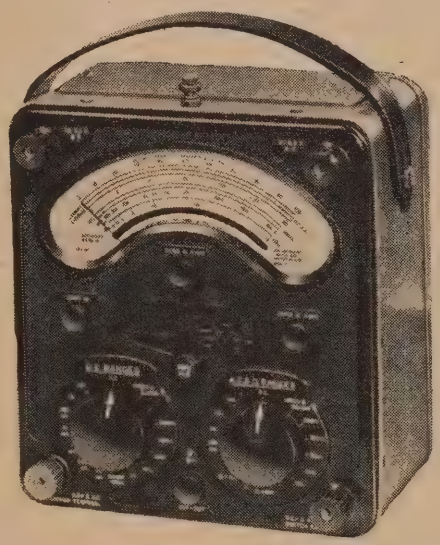

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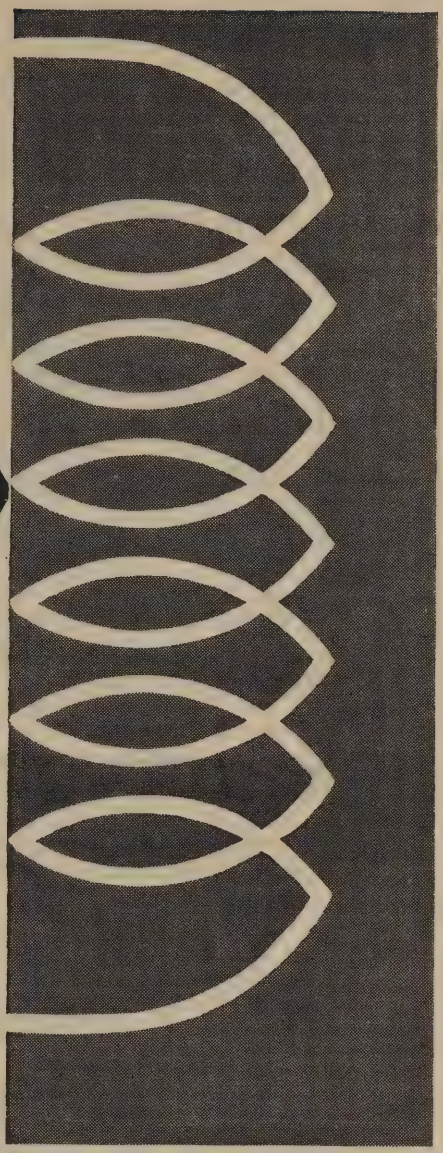

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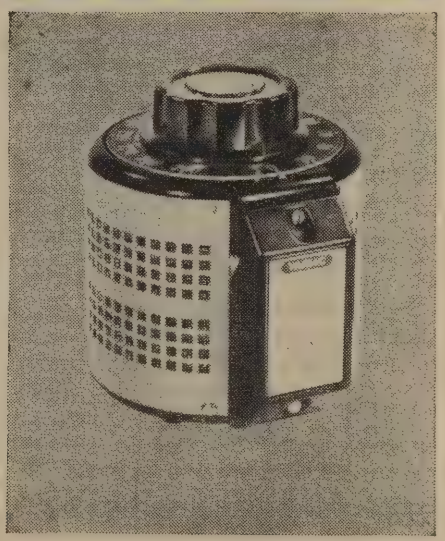

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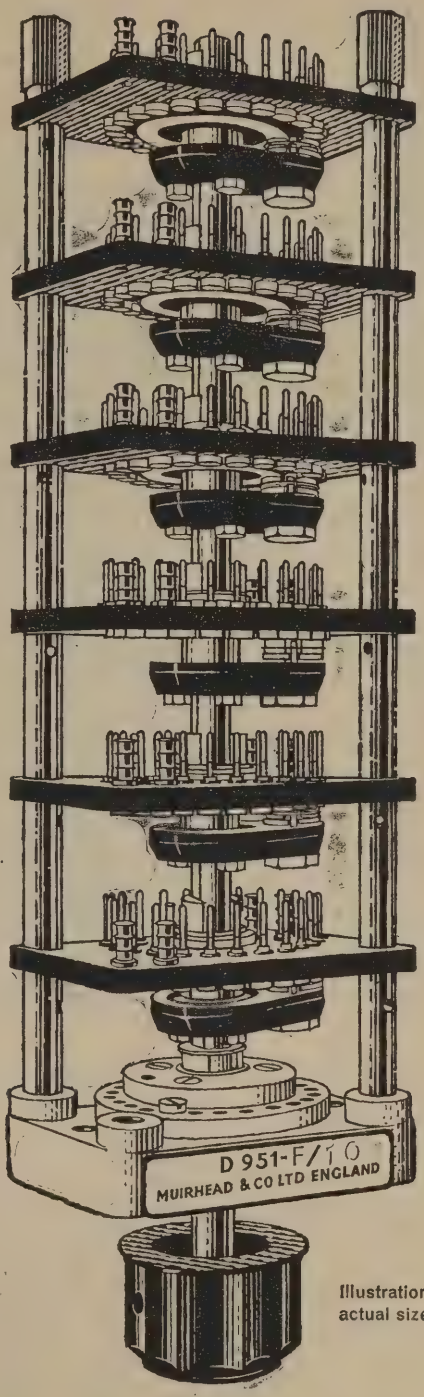

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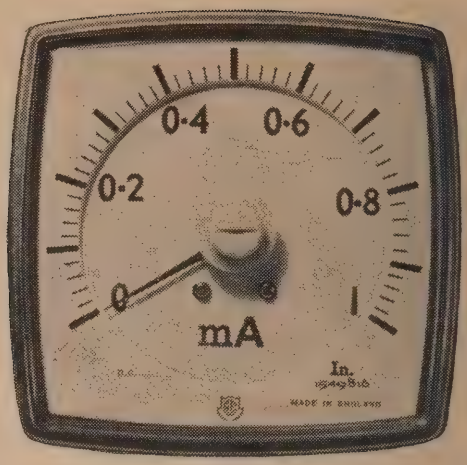

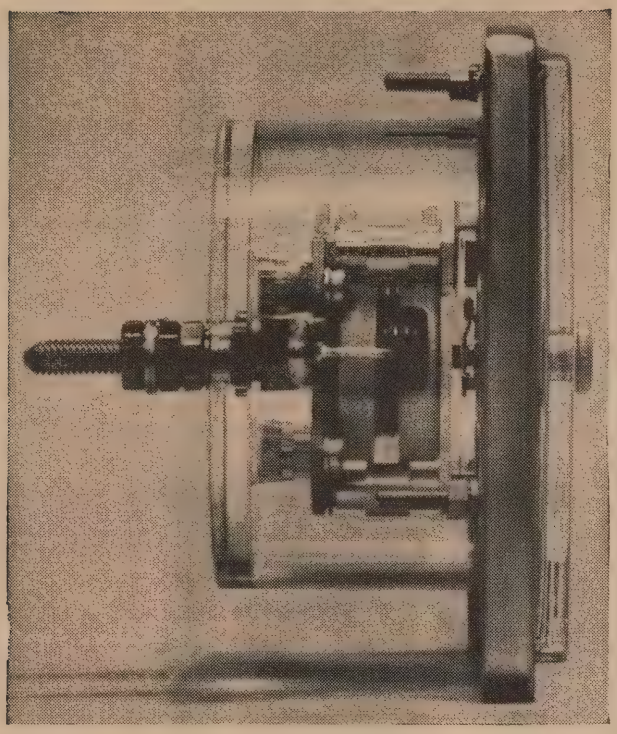

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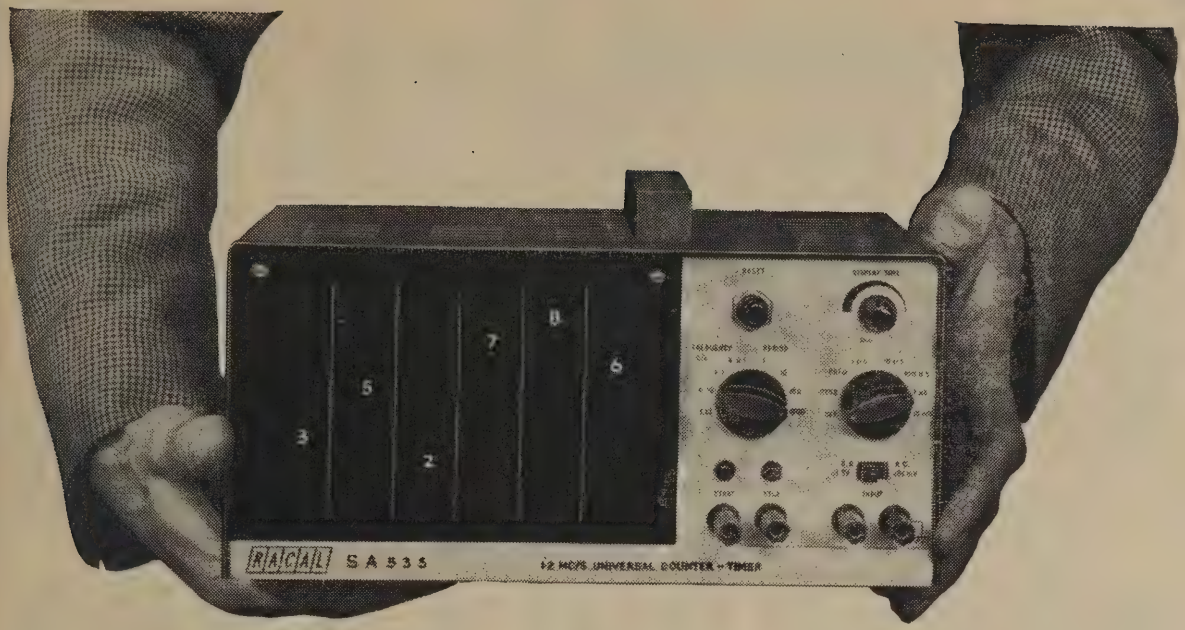

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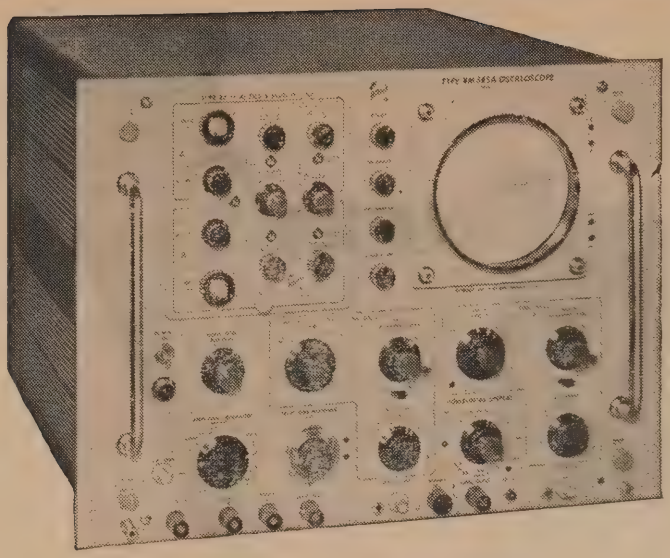

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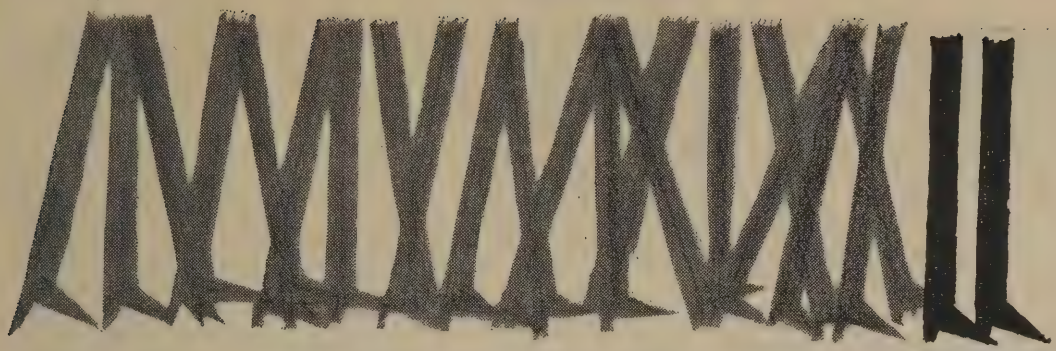

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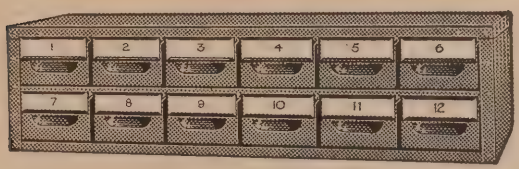

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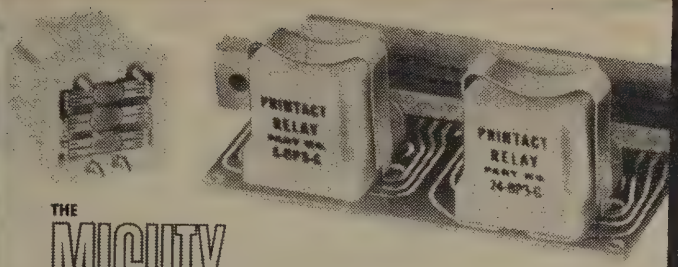

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Contact Material	Gold alloy or Palladium
Power Consumption	500 m/w (at rated voltage)
Operating Temperature	−30° C to +95° C at rated voltage
Operate Time	3 to 7 m/s. See Table II
Dimensions & Weight	⅞in. x ⅝in. x 1 3/16in.—0.8 oz.
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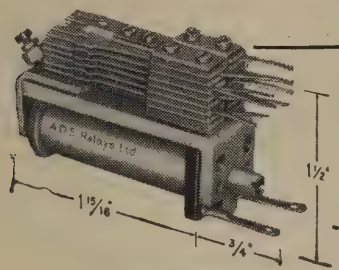

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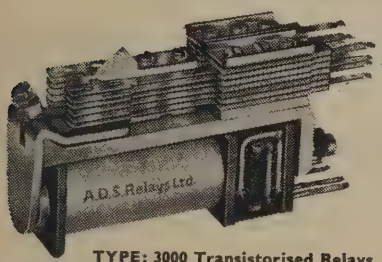
A.C. or D.C. Operating. Coil up to 10,000 ohms. Single or double winding. Contact Material—Silver, Platinum. Spring set—6 change-overs. Light Duty Maximum. Fixing same as 600T Relay. Standard or Tropical finish. Dimensions—length 2 1/16in. Height 1½in. Width ¾in.



TYPE: 3000 Transistorised Relays

T.1 Operates from 300 to 500 micro/amps. at 1½ volts D.C.

T.2 Operates from 3 to 5 micro/amps. at 1½ volts D.C. Maximum contacts 2 change-overs light duty or 2 change-overs heavy duty.

T.3 Operates from 15 to 30 micro/amps. at 1½ volts D.C. Maximum contacts six change-overs light duty.

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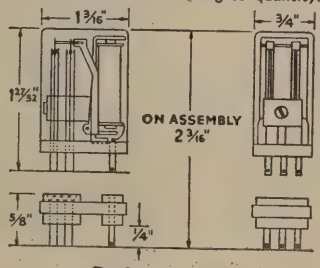

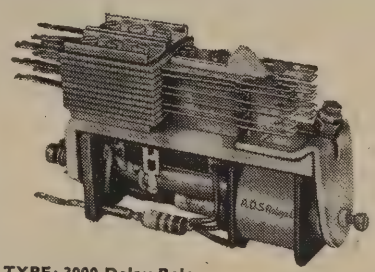

TYPE: 3000 Delay Relay
This relay can be supplied with operate/delay up to 25 seconds from supply of 6 to 50 volts D.C. Release delay up to 25 seconds with trigger circuits to 1½ volts D.C. Energised from 6 to 50 volts D.C. Contacts maximum 6 change-overs light duty.
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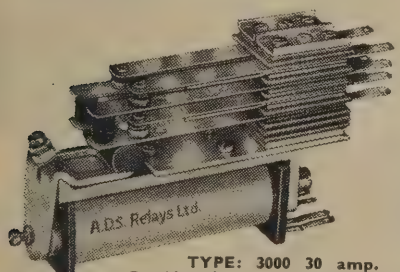

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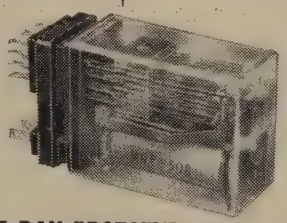
Capable of carrying 30 amps. at 250 v. A.C. with maximum build up of 4 makes or 4 breaks. Coil: .1 to 80.000 ohms.



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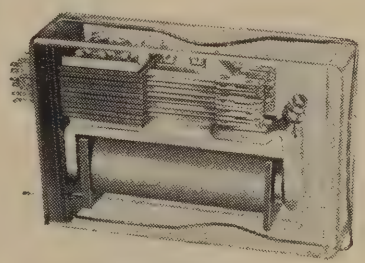

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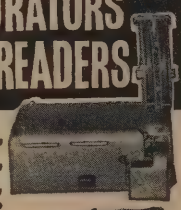

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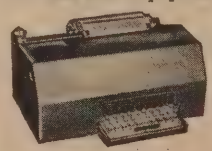

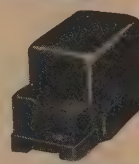

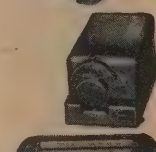

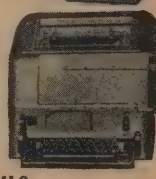

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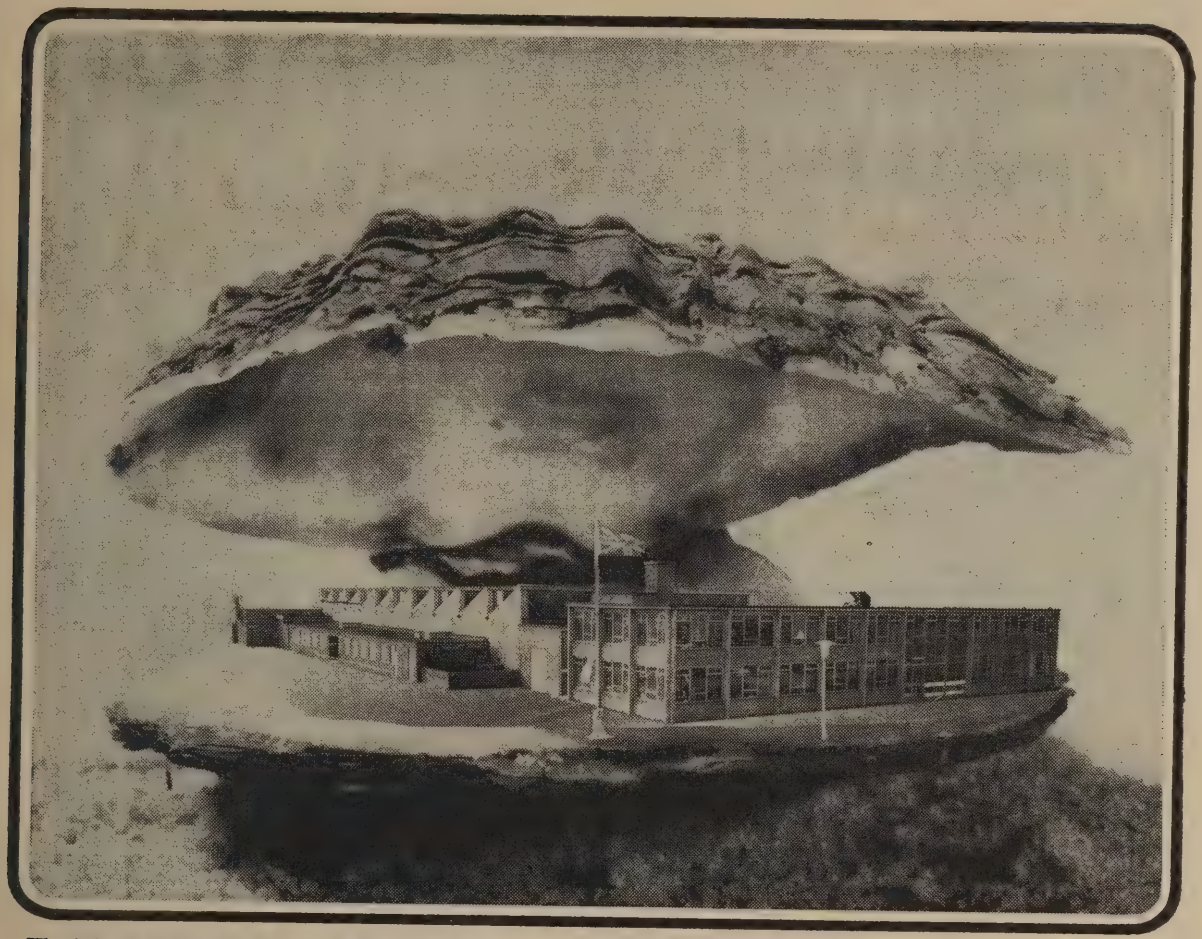

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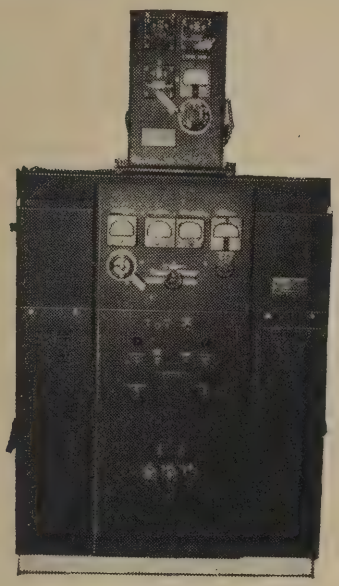

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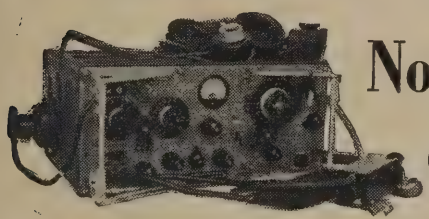

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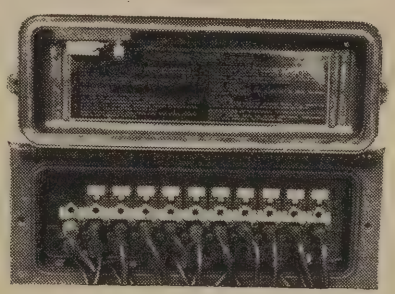

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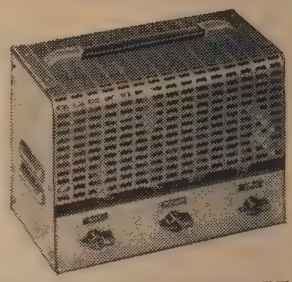

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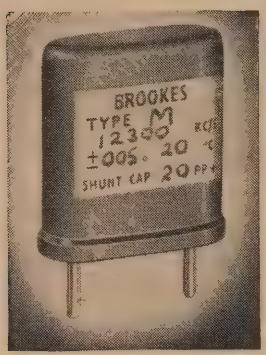

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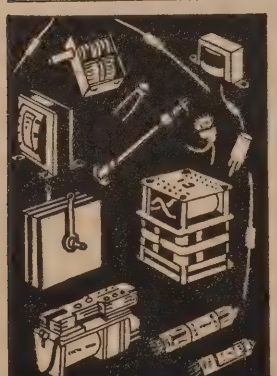

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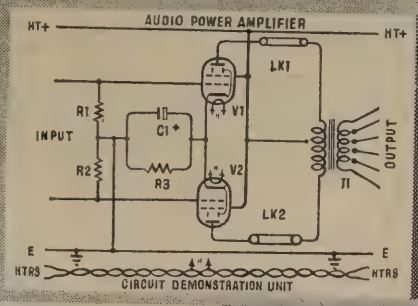

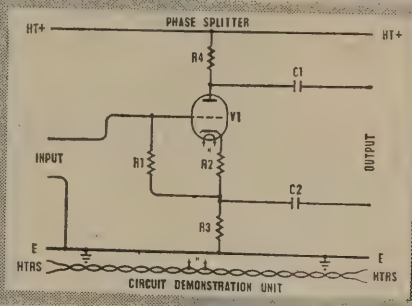

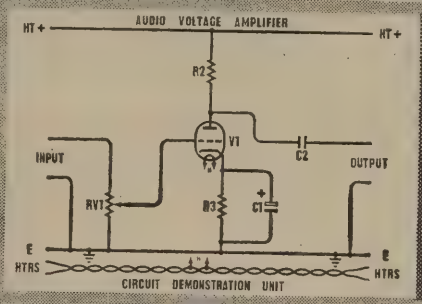

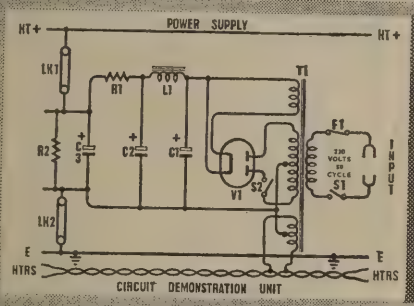

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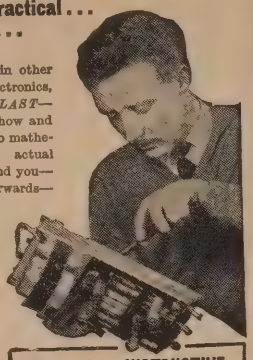

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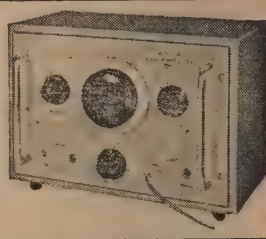

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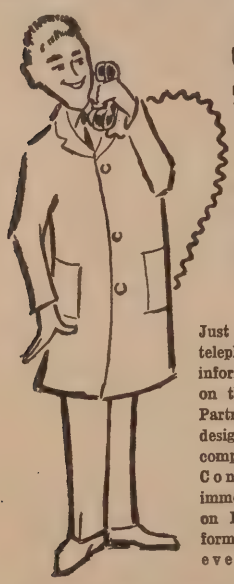

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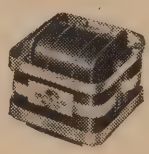

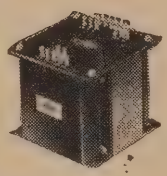

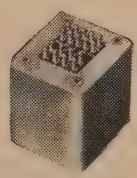

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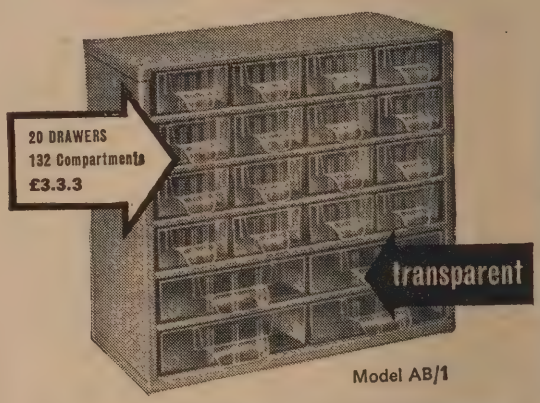

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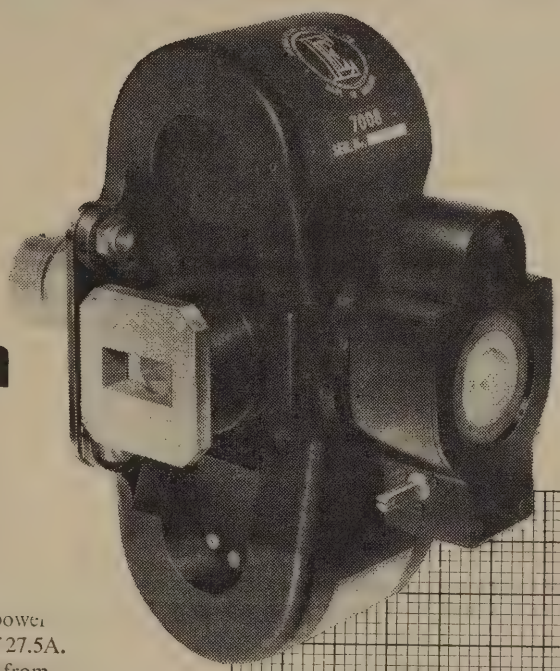
8500-9600 Mc/s



The EEV 7008 has a typical output power of 220kW at a peak anode current of 27.5A. It can be operated with pulse lengths from 0.20 to 2.75 μsec at a duty cycle of up to 0.0011.

Special features include:

- A minimum of 200kW peak output power over whole frequency range
- Linear tuning characteristics with coarse and fine calibrated dials
- Compact tuning mechanism designed for minimum backlash
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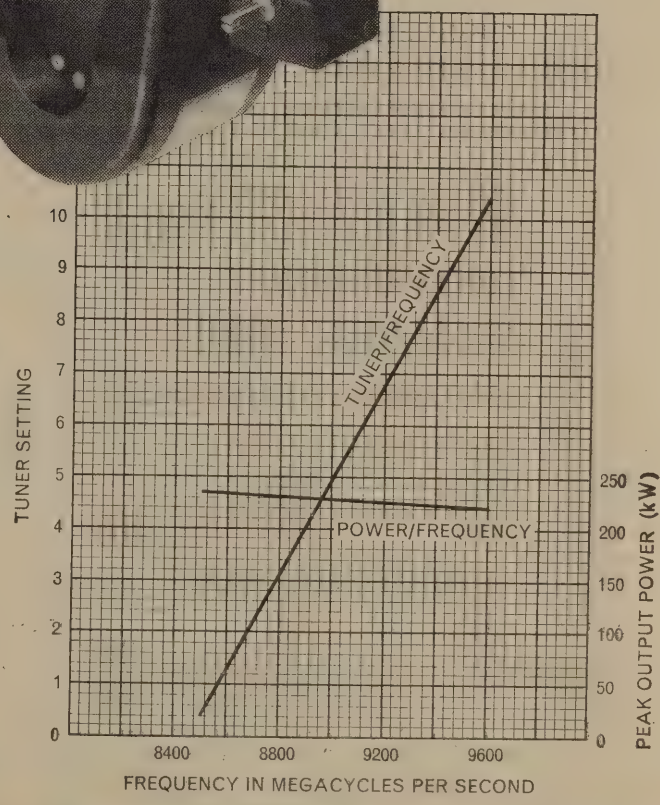
- Missed-pulse rate less than 0.2%
- High rate of rise of voltage
- Long-life cathode
- Unique heater construction gives greater reliability
- High efficiency anode cooling

For full technical data on the EEV 7008 tunable magnetron and others in the range, please write or 'phone Chelmsford 3491, Ex. 262.



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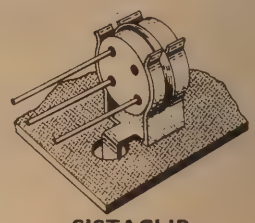

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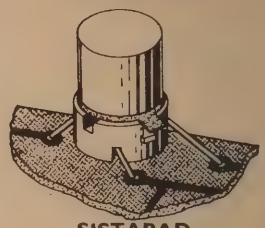

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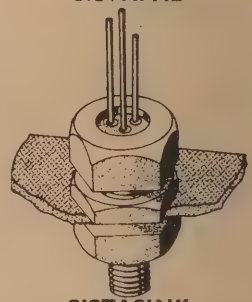

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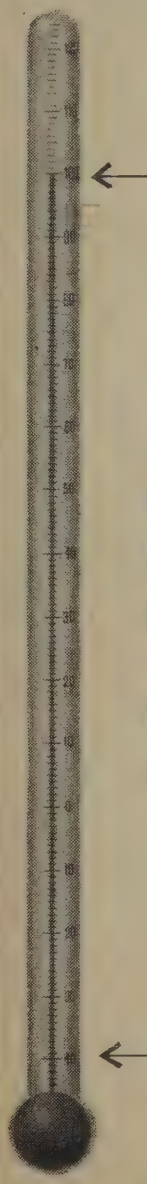

WHAT WE KNOW ABOUT WIDE TEMPERATURE RANGE CAPACITORS WOULD STRETCH FROM HERE TO HERE...

IEA EXHIBITION, MAY 25-30
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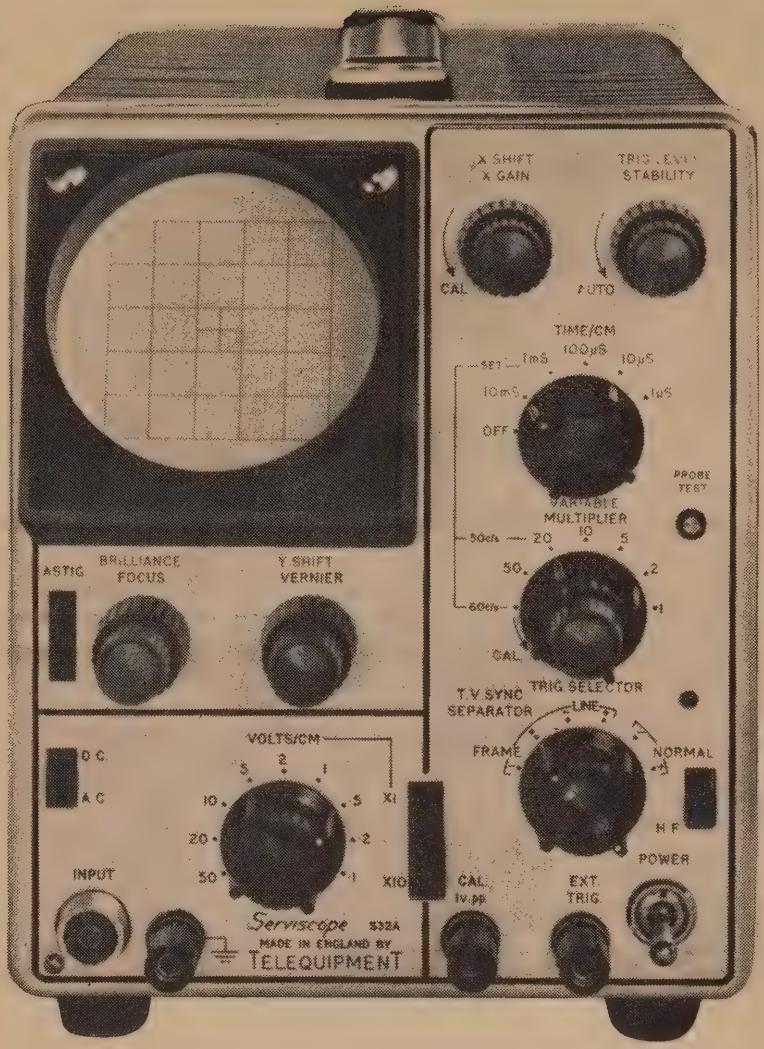

Portable, reliable, low-cost oscilloscopes by Telequipment

Telequipment produce a wide range of Serviscopes* and portable laboratory oscilloscopes to enable you to choose exactly the instrument you require for any particular purpose. For example, the Serviscope type S32A, illustrated above, is still the most popular small portable measuring oscilloscope in use today.

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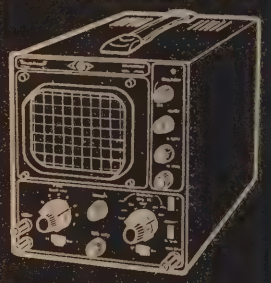
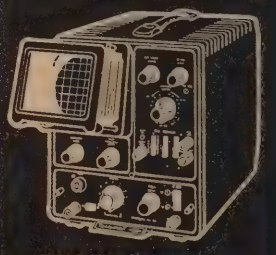
TELEQUIPMENT

Most portable models are also available in rack-mounted form. Ask for details.

D55A Double-beam oscilloscope with trigger delay, for advanced laboratory applications and computer industry. £275.



S51A Single-beam Serviscope* for industrial and educational use. £49.



S43A Single-beam wide band laboratory oscilloscope with interchangeable Y amplifiers. £92 with general purpose amplifier.

9WW—098 FOR FURTHER DETAILS.

Wireless World

ELECTRONICS, RADIO, TELEVISION

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JUNE 1964

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PRICE: 2s 6d.

FIFTY-FOURTH YEAR
OF PUBLICATION

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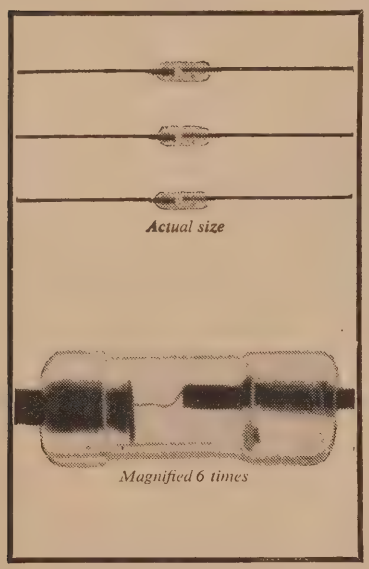
BA115-MULLARD SILICON DIODE

limits the visibility of white spot interference

A NEWLY-INTRODUCED DIODE—the Mullard gold-bonded silicon diode type BA115—will be encountered as an interference limiter in the latest television receivers.

Motor car ignition is probably the source of some of the most annoying television picture interference. When the signal transmission system uses positive modulation, as do BBC 1 and the ITA, any interference pulses can lead to a positive going component in the output of the video detector, which can easily exceed the normal signal level corresponding to peak white. Spots that are lighter than the whitest parts of the picture can therefore appear on the screen.

To reduce this irritating effect, a diode limiting circuit is often used which ensures that spikes above a predetermined level are removed before the signal reaches the picture tube. In such a circuit, the conditions imposed on the diode are particularly stringent, and the BA115 has been designed by Mullard to fulfil these special requirements:



- The maximum permissible reverse voltage of the diode must be high to withstand the high transient voltage; the BA115 is rated at 150V.
- The recovery time of the diode must be low to ensure a rapid response to the interference pulses; the BA115 has a forward recovery time of only 0·3 microseconds.
- The capacitance of the diode must be low to minimise its loading effect on the video amplifier; the signal capacitance of the BA115 is less than 5pF.
- A high reverse impedance at high temperatures is essential to minimise leakage currents; the leakage current of the BA115 is less than 20μA at an ambient temperature of 70°C when the reverse voltage is 100V.

The BA115 meets every demand made by an interference limiting circuit and is therefore making an important contribution to improved performance in the latest television receivers.

AD140—MULLARD OUTPUT TRANSISTOR

FOR CAR RADIOS

IN conjunction with a miniature driver transistor type OC82DM, the Mullard AD140 power transistor forms the audio package, type LCR2. This alloy-junction output transistor has a high current gain, and possesses good linearity and frequency characteristics.

The package forms a two-stage class A audio amplifier capable of delivering an output of 3W when driven directly from the detector of an all-transistor receiver. The sensitivity of the amplifier with respect to a 1kΩ source is typically 25mV for full output. The LCR2 is thus meeting the need for high audio gain in car radios, ensuring an excellent standard of performance while offering an economic design.

PCF 802 Line-Oscillator Triode-Pentode

FOR BBC 2 RECEIVERS

BBC 2 uses negative vision modulation, and dual-standard receivers have been produced in readiness for this employing line oscillators operating on the flywheel principle. The Mullard PCF802 triode-pentode was designed specifically for this type of circuit.

Mullard What's new in the new sets

In a typical mode of operation, the pentode section of the PCF802 will be used as a sine-wave oscillator whose frequency is controlled by the triode section of the valve functioning as a reactance valve. The d.c. frequency-control signal at the triode grid is obtained in a phase-frequency detector comparing the incoming synchronising pulses with pulses taken from the line output stage.

An attractive feature of this circuit is that only one switch is needed to change the frequency of the oscillator from that required for the 405-line standard—10·125kc/s—to that required for the 625-line standard—15·625kc/s.

Special attention has been paid in the development of the new valve to minimising hum and microphonic interference, which can be troublesome in this type of line-oscillator circuit. Furthermore, the amplification factor of the triode section of the valve is high, thus making the section particularly suitable for operation as a reactance valve.

Wireless World

VOL 70 NO 6 JUNE 1964

I.E.A., R. & D., S. & E.

TO be "with it" and to hold one's own in the game of "one-upmanship" it is necessary to know all the current acronyms and abbreviations and if possible to have up one's sleeve a private collection with which to parry attack (which may explain the cryptic title of this month's comment).

I.E.A. has now been admitted into the language not only of this country, but of the world. It should, of course, be I.I.E.A., for the show is international, but "I.E.A." like "Phys. Soc." is likely to stick. This year the exhibition, with approximately 700 firms showing an estimated £22M worth of apparatus, is bigger than ever and will attract many overseas buyers, for it is now universally recognized as one of the three or four leading electronic shows in the world. It is for this reason that we have devoted a considerable portion of this issue to a preview for the benefit of those unable to attend.

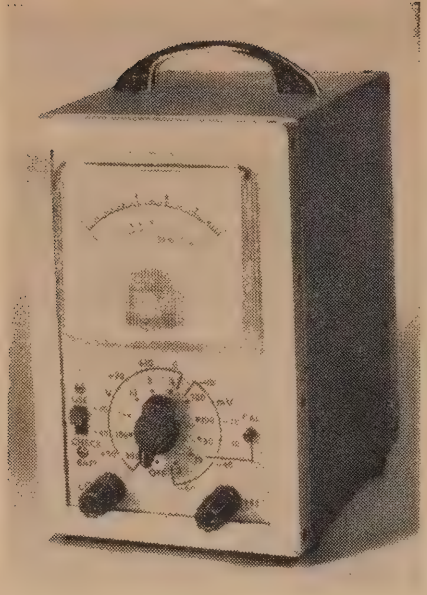
R. & D. to some people means something more than Research and Development. It has been current in America for quite some time and is now gaining currency in the U.K. While purporting to be a contemporary movement it seems to us to be our old friend applied research, and the distinction from pure research is the element of material gain which is added to the natural curiosity for new knowledge. There is still something unfinished about R. & D. which *The Times*, in choosing a title for its recent exhibition and conference at Olympia, has appreciated and remedied by extension to R.D.P. (Research, Development, Production). Recognizing the paramount importance of productivity, the exhibition showed how the methods of research and development should be channelled from the start of any new production to take into account the constraints of cost, reliability, ease of servicing, etc. as well as fitness for purpose. As a prelude to I.E.A. the R.D.P. exhibition was a fitting reminder of the way in which Science and Engineering combine to produce a saleable article.

S. and E, or rather S. *or* E., has been under discussion recently from another angle, namely the general preference shown by students for pure science rather than engineering as a course of study and later as a field for research. Apparently it is thought that science occupies a higher social status than engineering. As a corrective may we suggest that any fool can try something and write up the negative result in the jargon. He may even get a Ph.D. for it, but it takes a good man to produce work which will survive scrutiny at exhibitions like R.D.P. or I.E.A.

Playing on the Room

The announcement that the acoustics of the Royal Festival Hall have been changed by the introduction of active resonators operating at 3-c/s intervals up to 300c/s marks a further encroachment of electronics into the art of music making. Every musician—indeed every singer in his bath—knows that the room is an extension of his instrument or his vocal cavities. The joy of playing a fine violin resides not so much in its tone as in its "free playing" quality, which on analysis turns out to be the readiness with which it "speaks" or responds to the lightest touch of the bow. Stradivari had to achieve this by choice of wood and form. One wonders what he might have achieved had he been given modern electronic aids. Perhaps he would then have turned his attention to loudspeaker diaphragms. More certain is the fact that it is easier to play, as well as more pleasant to listen, in a reverberant environment than in, say, an echo-free test chamber, where even speech is hampered by a sense of claustrophobia (more accurately agoraphobia?).

Resonant absorbers have long been part of the stock-in-trade of broadcast studio designers who can level *down* the inequalities of the reverberation/frequency characteristic because they can also raise the whole response by amplification before broadcasting. But in a concert hall too much absorption makes both playing and listening hard work—too much like an open-air concert, in fact.



HIGH INPUT IMPEDANCE AND SENSITIVITY USING TRANSISTORS

Wireless World

A.C. MILLIVOLTMETER

WE have already described, in previous issues, an audio signal generator to provide test signals and an oscilloscope on which to observe the results of passing the signals through a piece of equipment under examination.

Oscilloscopes are all very well, but many measurements can be made under sine-wave conditions, and if one requires to know only, say, the gain or frequency response of the equipment, then an oscilloscope is unnecessarily complicated. For measurements such as this, the only requirements are a signal generator, which we already have, and an a.c. voltmeter.

To be capable of performing all the measurements needed on an audio amplifier or tape recorder, the voltmeter must have a high input impedance so that the circuit being measured is not appreciably shunted, a frequency response up to at least the frequency of a tape bias oscillator and a sensitivity sufficient to register the output of a microphone or pickup.

The instrument described here adequately fulfils these requirements, having an input impedance of 1 MΩ (10 MΩ on the higher voltage ranges), a frequency response which is virtually flat to well over 100 kc/s and sensitivity of 3 mV, full scale. The voltage scales are linear and a decibel scale is provided for convenience in plotting frequency response curves. A calibrating square wave, with a peak amplitude of 10 mV is available at the front panel to take account of any variations in amplifier gain, although this facility is not absolutely necessary and may be omitted if desired. The instrument costs about £12 to make.

Principle of Operation

The instrument is of the type known as an "amplifier-rectifier." This means that the signal is first

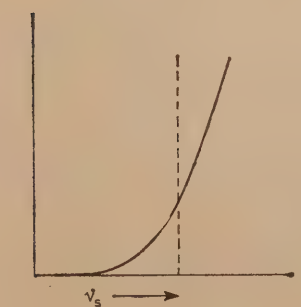


Fig. 1. Variation of diode current with voltage.

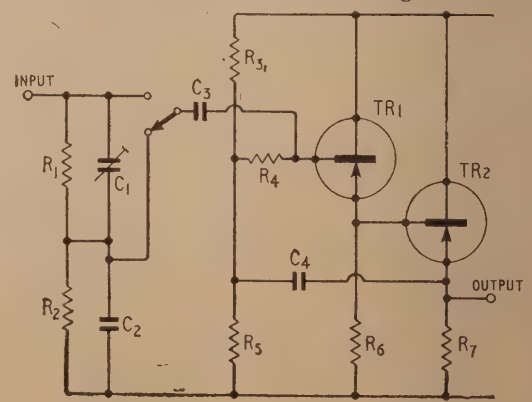


Fig. 2. High input-impedance input stage.

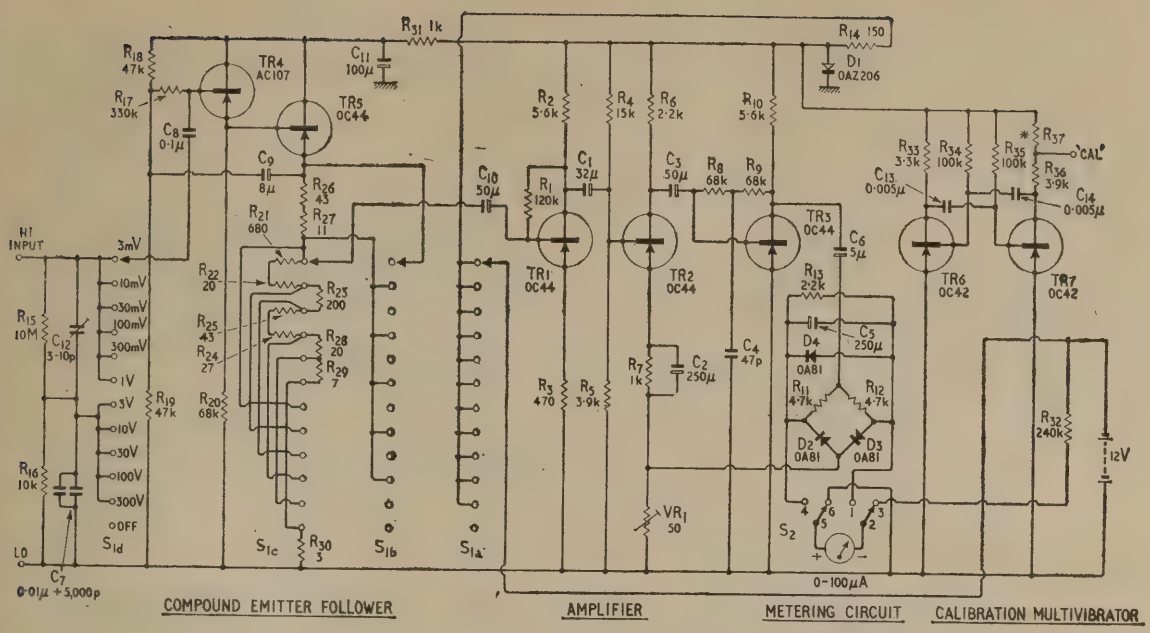


Fig. 3. Circuit diagram and (below) list of components of millivoltmeter.

Capacitors

C_1	32μF	Electrolytic
C_2	250μF	,,
C_3	50μF	,,
C_4	47pF	±10% ceramic
C_5	250μF	Electrolytic
C_6	5μF	,,
C_7	0.01μF	30V ,, Disc Ceramic in parallel with 5,000pF ±10% ceramic
C_8	0.1μF	350V
C_9	8μF	Electrolytic
C_{10}	50μF	,,
C_{11}	100μF	,,
C_{12}	3-10pF	Beehive Trimmer
C_{13}	5000pF	±10% ceramic
C_{14}	5000pF	,, ,,

All electrolytics sub-miniature 15V, Radiospares.

Resistors

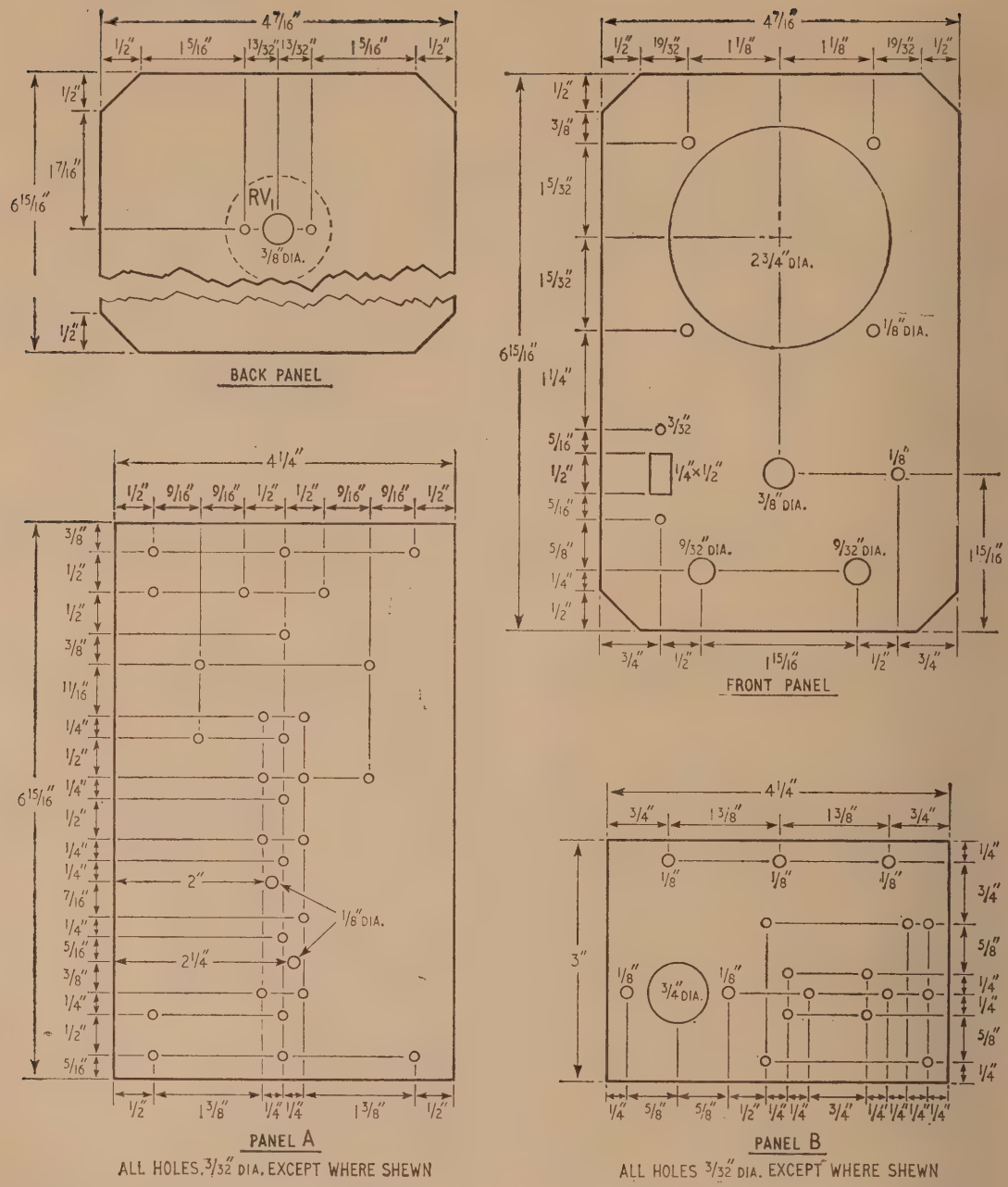
R_1	120kΩ	±10%	½W
R_2	5.6kΩ	,,	,,
R_3	470Ω	,,	,,
R_4	15kΩ	,,	,,
R_5	3.9kΩ	,,	,,
R_6	2.2kΩ	,,	,,
R_7	1kΩ	,,	,,
R_8	68kΩ	,,	,,
R_9	68kΩ	,,	,,
R_{10}	5.6kΩ	,,	,,
R_{11}	4.7kΩ	,,	,,
R_{12}	4.7kΩ	,,	,,
R_{13}	2.2kΩ	,,	,,
R_{14}	150Ω	,,	,,
R_{15}	10MΩ	± 5%	½W Hystab } Radiospares
R_{16}	10kΩ	,,	,, ,, }
R_{17}	330kΩ	±10%	,,
R_{18}	47kΩ	,,	,,
R_{19}	47kΩ	,,	,,
R_{20}	68kΩ	,,	,,
R_{21}	680Ω	± 5%	½W Hystab }
R_{22}	20Ω	,,	,, ,,
R_{23}	200Ω	,,	,, ,,
R_{24}	27Ω	,,	,, ,, } Radiospares
R_{25}	43Ω	,,	,, ,,
R_{26}	43Ω	,,	,, ,,
R_{27}	11Ω	,,	,, ,,
R_{28}	20Ω	,,	,, ,,
R_{29}	7Ω	wirewound, 16.8 inches of 36 s.w.g. Eureka	
R_{30}	3Ω	wirewound, 7.25 inches of 36 s.w.g. Eureka	
R_{31}	1kΩ	±10%	½W
R_{32}	240kΩ	± 5%	½W Hystab Radiospares
R_{33}	3.3kΩ	±10%	½W
R_{34}	100kΩ	,,	,,
R_{35}	100kΩ	,,	,,
R_{36}	3.9kΩ	,,	,,
R_{37}	10Ω	,,	in parallel with a resistor approx 100Ω to be chosen on calibration
VR_1	50Ω	Preset control—Radiospares	

Semiconductors

3 × OA81 Diodes
1 × OAZ 206 Zener Diode
4 × OC44 Transistors
1 × AC107 Transistor
2 × OC42 Transistors

Miscellaneous

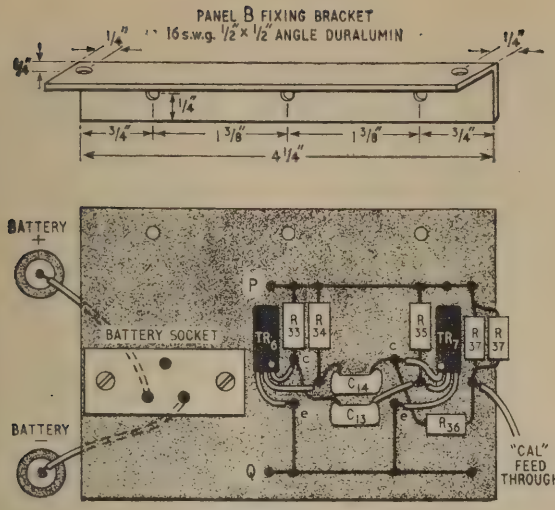
$\frac{1}{16}$in thick paxolin sheet
$\frac{1}{2}$in Duralumin or aluminium angle
16 s.w.g. Aluminium sheet
Formica for front and rear panels
1 × Feedthrough bush
1 × 100μA Type MR65P Meter available from: G. W. Smith & Co. Ltd., 3-39 Lisle Street, London, W.C.2.
Miniature 3-pin socket and plug
2 × PP1, 6V batteries or equivalent
4 × Battery connecting clips
1 × Black terminal
1 × Red ,, } Radiospares
Small Turret Tags
1 × Miniature 2-pole 2-way slide switch
1 × Makaswitch standard shafting assembly
4 × 1 pole, 12-way Makaswitch wafers
6 × short Makaswitch spacers
2 × medium ,, ,,
2 × long ,, ,,
4 Rubber feet
1 Pointer knob



Drilling diagram for component boards, front and rear panels. Boards are of paxolin and panels of 16 s.w.g. aluminium faced with Formica.

amplified before being applied to the rectifier which produces the direct metering current. The other type—the "rectifier-amplifier"—has several disadvantages, one of which renders it unsuitable for low-level measurements. The diode used to rectify the signal requires several hundred millivolts r.m.s. of a.c. applied across it before it begins to perform its rectifying function. Fig. 1 shows that the current through the diode increases very slowly at first, and only as the signal v_s reaches the dotted line does the curve become at all steep and linear. This type of voltmeter, therefore, is limited to measurements on signals greater than, say, 150 mV, and consists of the diode followed by a directly-coupled amplifier to increase the output of the diode sufficiently to operate the meter. The rectifier-amplifier type is used chiefly for relatively high level measurements at frequencies up to 1000 Mc/s or more.

On the other hand, the amplifier-rectifier type must possess an amplifier capable of handling the band of frequencies of interest, a problem which also imposes limitations of a different nature. The higher voltage across the diode gives greater linearity, which can be further improved by negative feedback. This

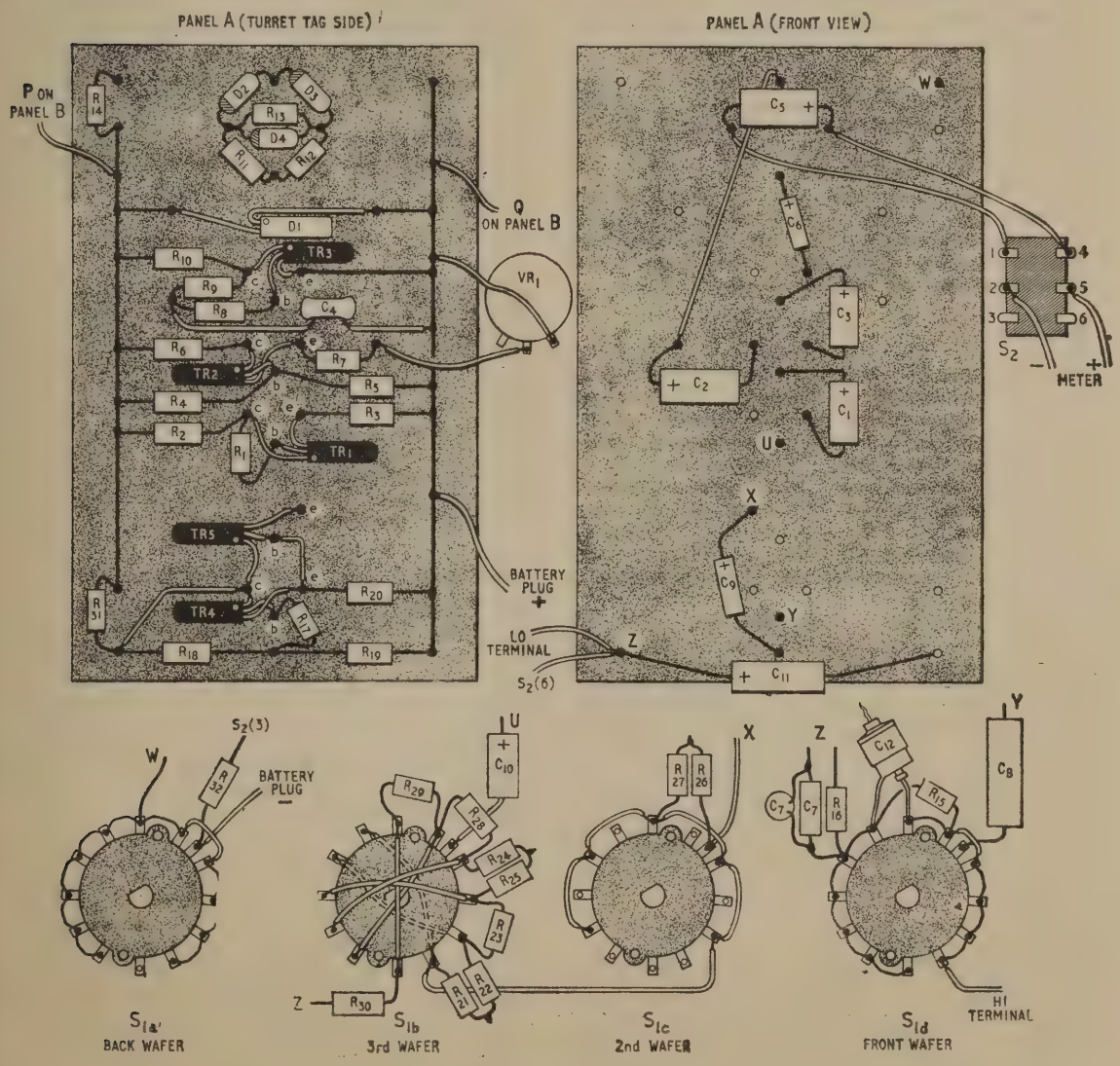


◀ *Layout of cal. oscillator board.*

type is accordingly mainly used for low-level, relatively low-frequency work, although instruments have been designed which will measure 3mV at up to 50 Mc/s.

A point to remember about all instruments using moving-coil meters is that they respond to the average, or mean, value of the signal voltage. In a sine wave this differs from the r.m.s., or effective value by a factor of 1.11, but *only in a sinusoidal wave.* Most meters, ours included, are calibrated to read r.m.s. values, although responding to the average, because r.m.s. voltages are the ones we wish to know. This means that if the signal is not sinusoidal, the reading will be in error, unless square waves **are**

▼ *Wiring diagram and layout.*



used, in which case peak, r.m.s. and average values are identical.

Input Stage

As mentioned previously, an important requirement of a millivoltmeter for many applications is that it should possess high input impedance. Unlike valves, transistors are not ideal voltage amplifiers. They are normally considered to be current-operated devices with low input resistance. Typically, a common-emitter transistor stage has an input resistance of about 1.5 kΩ, which is completely useless for voltage measurement unless the signal source impedance is less than about 70 Ω. To improve the situation, an emitter follower can be used to give an input impedance of $h_{fe}R_e$, where h_{fe} is the common-emitter current gain, otherwise known as α or β, and R_e is the emitter resistor. About 50 kΩ-100 kΩ can be obtained in this way, at the loss of all the gain, and even more improvement is obtained by a second emitter follower, the two being called a Darlington pair, shown in Fig. 2. An additional component, C_4, provides "bootstrap" feedback from Tr2 emitter to Tr1 base, with the result that, when the base end of R_4 is driven negative by the signal, the remote end is also driven negative by the emitter of Tr2 *via* C_4, so that the change of current through R_4 is reduced. R_4 therefore "looks" greater than it is, and is still sufficiently small to allow base current for Tr1 to flow. As any noise voltages generated by Tr1 are amplified and registered by the meter, a low-noise type—the AC107—is used. The voltage gain of the pair of transistors is very close to one and the input resistance is 1 MΩ.

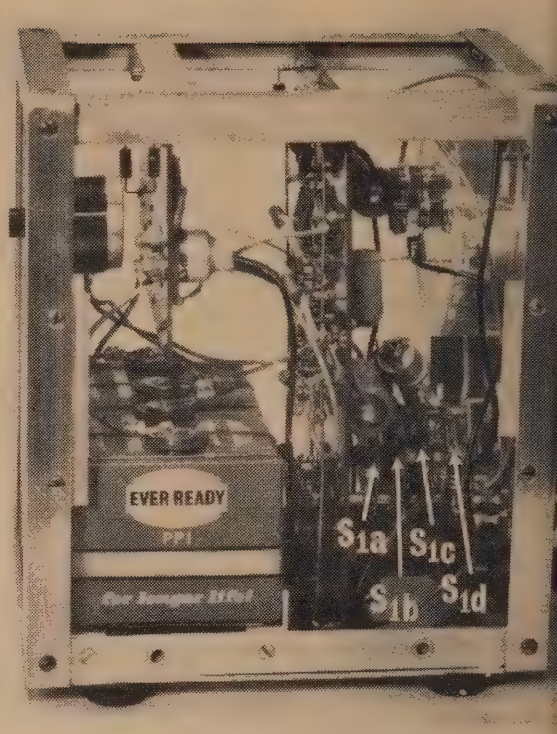
Attenuator

The attenuator is arranged to provide 3 mV to the main amplifier for full-scale deflection on each range. There are eleven ranges, and to frequency-compensate all eleven would involve more components than can reasonably be justified. The attenuator is, therefore, split into two parts. At the input is a 60 dB (1,000:1) voltage divider which gives two *groups* of ranges — 3 mV to 1 V and 3 V to 300 V. This divider is compensated by C_7 and C_{12} in Fig. 3 and, R_{15} being 10 MΩ, serves to increase the input impedance on the higher ranges.

The smaller steps, the individual ranges, are obtained from a divider in the emitter of Tr5. This chain has a total resistance of 1,000 Ω and is low enough in value not to need compensation for stray capacitance. As each range is ±10 dB relative to the adjacent ones, odd values of resistor would normally have to be used in the chain to obtain the 3.16:1 steps. In this case, however, preferred values of close-tolerance, high-stability resistors were used, and a resistor switched in and out at the top of the chain by S_{1c} to make up the difference. S_{1d} is merely the battery on-off switch.

Amplifier

The main amplifier consists of three stages, with negative feedback to stabilize the gain and linearize the scale. In the absence of feedback, the diode characteristic would give a scale cramped at the bottom end and accuracy would suffer. An unfortunate by-product of the negative feedback is that the gain of the amplifier is reduced, but as distortion generated in the amplifier and metering circuit is reduced by roughly the same amount, it is considered worth while. We have about 20 dB of feedback, which means that the gain of the amplifier is reduced 20 dB or ten times, and the exact amount is made adjustable by VR_1 to set the gain. The third stage has a little frequency compensation applied to it by means of the 47 pF capacitor, C_1 in its bias network. Negative feedback is applied *via* the network from collector to base and is reduced at high frequencies.



Inside view of instrument.

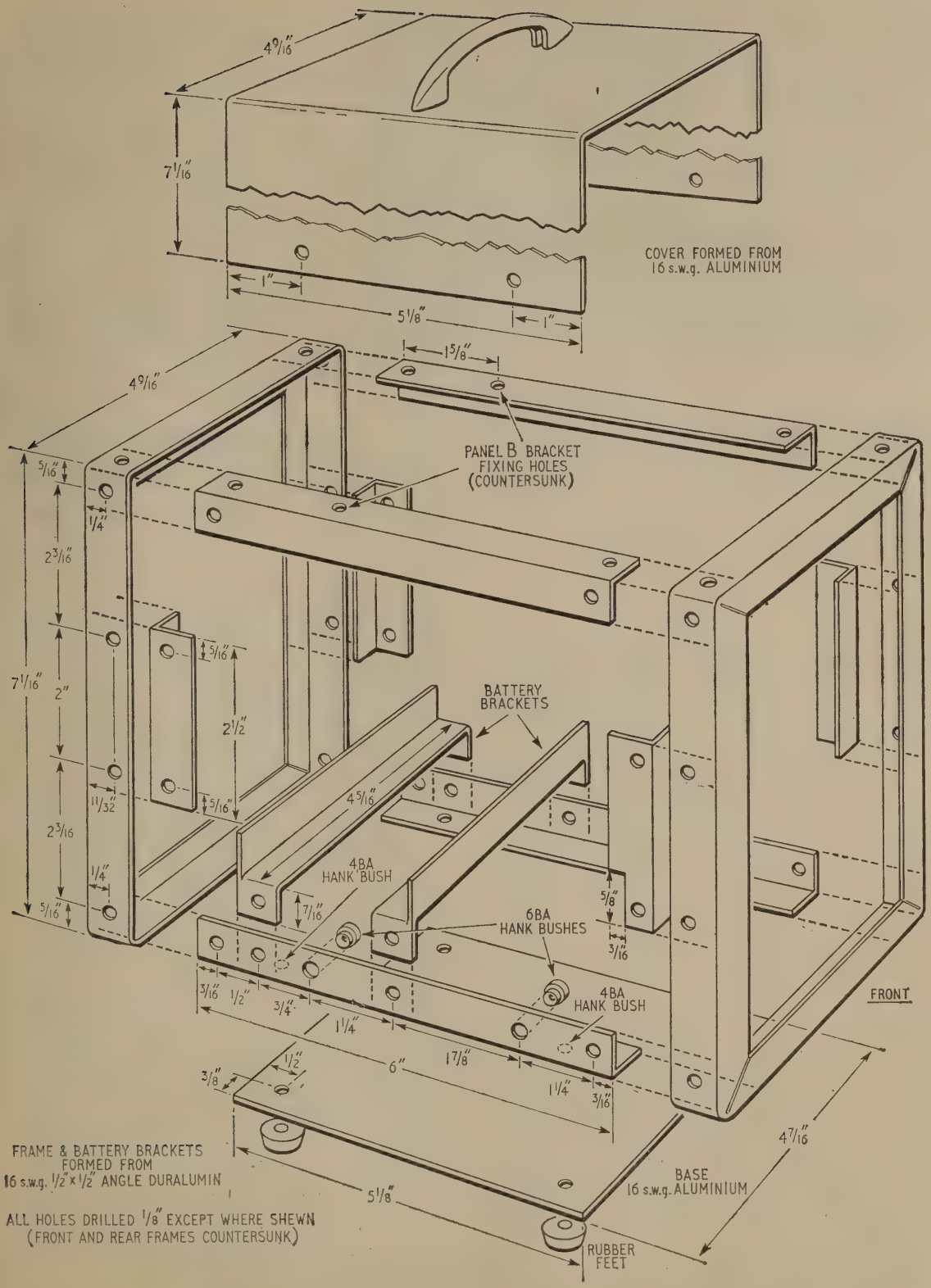
Metering

A half bridge is used as the rectifier, the "bottom" end being returned to the emitter of Tr2 to provide the negative feedback. The meter is protected against large accidental overloads by the diode across it, which conducts when a safe voltage is exceeded.

The meter is also used to check the battery voltage, this function being selected by S_2. The series resistor, R_{32}, is chosen to give a convenient scale reading with the meter used. With the specified meter, 240 kΩ gives a full-scale deflection of 20 V.

Calibration Oscillator

To make absolutely sure that the gain of the instrument has not changed, it is always a good thing to be able to check it against a stable signal, and we therefore provided a calibrating oscillator. It takes the form of a conventional collector-coupled astable multivibrator, using OC42 switching transistors and fed from the 8.2 V stabilized line. The 20 mV p.p. square wave produced at the junction of R_{36} and R_{37} is equivalent to a 10 mV r.m.s. sine wave, so that if



Assembly of case.

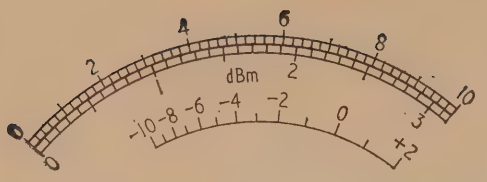


Fig. 4. Specimen meter dial shown actual size.

the "CAL" terminal is connected to the "HI" terminal when S_1 is switched to 10 mV, the "set gain" control, VR_1, can be adjusted to give full scale deflection and the gain is set.

Construction

The drawings should be self-explanatory, it only being necessary to remark (readers' letters in mind) that the circuit is entirely suitable for adaptation to printed circuitry. We have used our familiar tagboard method because we think it has the same advantages as printed boards, and is considerably less messy for the home constructor. The front panel can be lettered with Letraset (from drawing-office suppliers) by UNO stencil, or simply drawn by hand. A good method of finishing the metal cover is to put some light oil on it and rub it with steel wool, keeping the strokes in one direction. The result is a pleasant satin effect, and a coat of clear varnish protects it from finger marks.

Calibration

Three scales are used. The two voltage scales are calibrated 0-10 and 0-3.16, the ratio between them being −10 dB. The decibel scale is calibrated from −10 to +2 dB relative to 1 mW in 600 Ω, which corresponds to 0.775V.

To calibrate the three scales, it is only necessary to obtain full-scale deflection on the "10" scale. A mains transformer and potentiometer should be set to give 1, 10 or 100 V, this being measured with an ordinary testmeter. Apply this voltage to the millivoltmeter input, set to the appropriate range, and adjust RV_1 to obtain full-scale deflection. The gain is now set, and point "10" can be marked. The "10" scale should now be divided into equal divisions as in Fig. 4. The "3" and "dB" scales can be transferred from the "10" scale by means of Table 1 and Table 2. It is helpful if the three scales are marked in colours corresponding to the legend on the front panel.

R_{37}, the top arm of the multivibrator output divider, should be selected to give full-scale deflection when the "CAL" terminal is connected to the "HI" input, with the switch set to 10 mV.

The trimmer, C_{12} on the input attenuator must be set up to give a level response up to 200 kc/s. For this purpose, access to an oscillator is required, the reading at frequencies over about 10 kc/s being made equal to those at low frequency by means of the trimmer.

TABLE 1

"3"	"1"	"3"	"1"
0.1	0.32	1.7	5.38
0.2	0.63	1.8	5.69
0.3	0.95	1.9	6.01
0.4	1.26	2.0	6.32
0.5	1.58	2.1	6.64
0.6	1.90	2.2	6.96
0.7	2.21	2.3	7.27
0.8	2.53	2.4	7.59
0.9	2.85	2.5	7.91
1.0	3.16	2.6	8.22
1.1	3.48	2.7	8.54
1.2	3.80	2.8	8.85
1.3	4.11	2.9	9.17
1.4	4.43	3.0	9.49
1.5	4.74	3.1	9.80
1.6	5.06		

TABLE 2

"dB"	"1"	"dB"	"1"
+ 2	9.75	− 5	4.36
+ 1	8.69	− 6	3.88
0	7.75	− 7	3.46
− 1	6.90	− 8	3.08
− 2	6.15	− 9	2.75
− 3	5.48	−10	2.45
− 4	4.89		

The trimmer, C_{12} on the input attenuator must be set up to give a level response up to 200 kc/s. For this purpose, access to an oscillator is required, the reading at frequencies over about 10 kc/s being made equal to those at low frequency by means of the trimmer.

SPECIFICATION

Volt ranges

3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, 300V, f.s.d.
Decibel ranges −60 to +50, −10 to +2 on scale.

Accuracy

±5% of reading.

Response

±0.5dB from 20c/s to 200kc/s.
±3dB from 10c/s to 450kc/s.

Input Impedance

1MΩ+60pF at 3mV f.s.d.
1MΩ+40pF at 10mV f.s.d.
1MΩ+35pF at 30, 100, 300mV and 1V f.s.d.
10MΩ+18pF at greater than 3V f.s.d.

Noise level

40μV referred to input with input shorted.

JUNE CONFERENCES AND SHOWS

2-4 Philadelphia
Global Communications Symposium
(I.E.E.E., Box A, Lennox Hill Station, New York)

2-4 Los Angeles
National Telemetering Conference
(I.E.E.E., Box A, Lennox Hill Station, New York)

2-6 Budapest
Acoustics Conference
(Soc. for Optics-Acoustics, Szabadság tér 17, Budapest)

8-10 New York
Symposium on Quasi-optics
(Polytechnic Inst. of Brooklyn, New York)

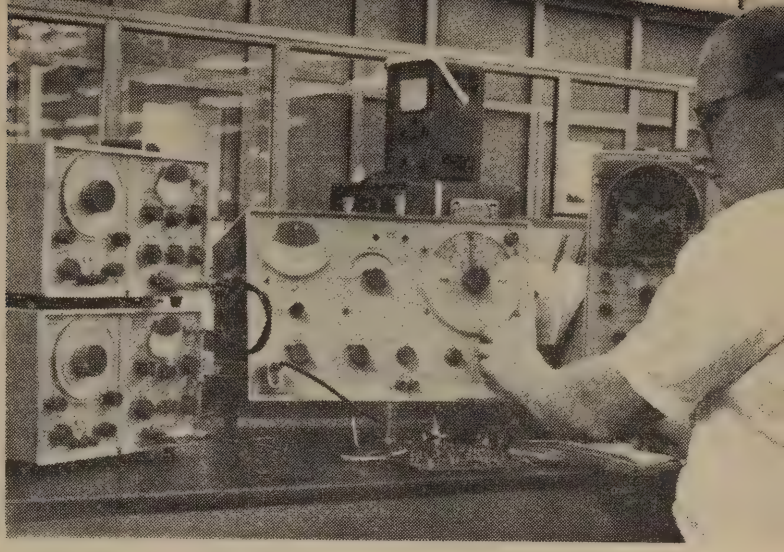
15-16 Chicago
Conference on Broadcast & TV Receivers
(I.E.E.E., Box A, Lennox Hill Station, New York)

15-18 Coventry
Conference on Protection from Noise
(Society of Acoustic Technology, c/o Dr. P. Lord, College of Advanced Technology, Salford)

18-29 Rome
Electronics, TV, Radio & Cinematograph Fair
(A.N.I.E.E., via Donizetti 30, Milan)

23-25 Boulder
Precision Electromagnetic Measurements
(National Bureau of Standards, Boulder, Colorado)

BASIC METHODS OF MEASUREMENT AND THE COMPARATIVE MERITS OF THE SYSTEMS



Intermodulation Distortion Measurement

By D. E. O'N. WADDINGTON*, A.M.I.E.R.E.

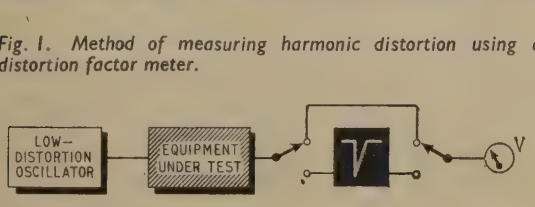
THE primary purpose of a distortion measurement is to assess the ability of an amplifier or other equipment to handle a signal. This statement may seem obvious but, what is not so obvious is that the method used should be adequate to provide a useful answer; useful in predicting performance under operational conditions or useful in indicating what steps should be taken to improve the performance. Two basic methods of distortion measurement are commonly used, viz., (i) single-signal harmonic distortion measurement and (ii) two-signal intermodulation distortion measurement.

Single-signal Method

This is the simplest method but it has an inherent difficulty in that a signal having a very low distortion content is a prime necessity. With modern test gear this is not insuperable but, if measurements of better than 0.1% distortion are to be made with any accuracy, it is generally necessary to use filters to " clean " the wave form.

Given a pure signal, there are two methods of measuring harmonic distortion. The first and simplest is to use a distortion factor meter (Fig. 1). This consists essentially of a tunable rejection filter followed by a voltmeter. Its mode of operation is as follows:—First the signal + distortion is measured. The stop filter is then switched into circuit and tuned so as to reject the fundamental. The residual signal which will consist of noise and harmonic components is then measured by the voltmeter. This measurement is then related to the first to give the percentage harmonic distortion. The main disadvantage of this method of measurement is that the distortion is measured as a single composite signal there being no differentiation between harmonic components. This defect may be overcome, however, by observing the residual signals on an oscilloscope when it is possible to assess their composition.

Fig. 1. Method of measuring harmonic distortion using a distortion factor meter.



More precise harmonic distortion measurements may be made by using a wave analyser to measure the individual harmonic components. The percentage harmonic distortion may be then calculated from the formula:—

$$\frac{\sqrt{E_2^2 + E_3^2 + \ldots}}{E_1} \times 100$$

when E_1 is the amplitude of the fundamental component and E_2, E_3, etc. are the amplitudes of the harmonic components.

Two-signal Methods

There are two standard methods for making two-signal measurements, C.C.I.F. [1] and S.M.P.T.E.[2]. These methods frequently give widely differing results but each is very useful in its own field and it is often revealing to use both methods when assessing an equipment. The main advantage of two-signal methods is that there is no necessity for extreme purity of the test signals. A further advantage is that it more nearly simulates operating conditions.

C.C.I.F. In this system, two signals (" P " and " Q ") of equal amplitude but with a relatively small frequency difference are applied simultaneously to the equipment under test via a suitable combining network (Fig. 2). The resultant output is monitored

*Marconi Instruments Ltd.

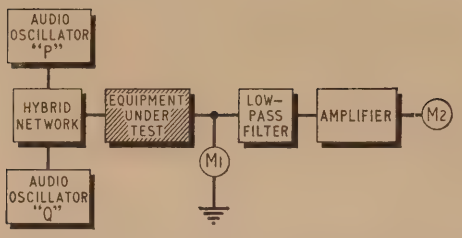


Fig. 2. C.C.I.F. system of intermodulation distortion measurement.

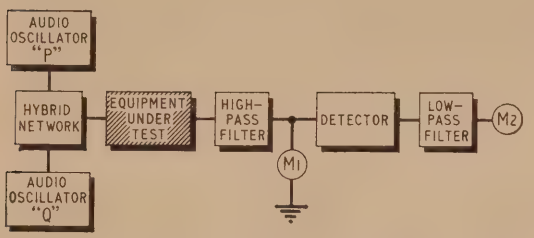


Fig. 3. In the S.M.P.T.E. system of measurement, the low-frequency signal has an amplitude four times that of the high-frequency signal.

by the peak-reading voltmeter M1 and then fed through a low-pass filter which rejects "P" and "Q". The even order inter-modulation products P−Q, 2(P−Q), 3(P−Q), etc. are passed by the filter and measured by the meter M2. The percentage inter-modulation distortion is then given by the formula:—

$$\frac{\text{Intermodulation product amplitude}}{V_P + V_Q} \times 100$$

This method of measurement does not give any indication of the odd order intermodulation products (2P−Q), (3P−2Q), etc. These may best be measured by means of a wave analyser.

The most useful region of application for this system is at the upper end of the pass band of an amplifier where the frequency response is beginning to fall off. Here simple harmonic analysis tends to give erroneous results. The important precaution to observe in using this system is that the difference frequency chosen should be within the pass band of the equipment under test.

S.M.P.T.E. This system uses a high-frequency signal "P" and a low-frequency signal "Q", which has an amplitude four times that of "P". These signals are combined in a suitable hybrid network and applied to the equipment under test (Fig. 3). The output is fed through a high-pass filter which rejects the low-frequency signal "Q". The modulated high-frequency signal consisting of P (P + Q), (P−Q), (P + 2Q), (P−2Q) etc. is then detected and fed through a low-pass filter so as to select only the modulation products, which are then rectified and fed to the meter M2. The amplitude of this signal is then measured as a percentage of the high-frequency signal, thus giving the percentage inter-modulation distortion. The main precaution to be observed in using this system of measurement is to ensure that the low-frequency signal is within the pass band of the equipment under test.

In common with the distortion factor meter this instrument gives no indication as to whether the distortion is due to odd or even order components in the transfer characteristic. Thus, while these methods may be sufficient for production line testing, design engineers will find that a wave analyser gives more revealing and hence, more useful results.

Theoretical Considerations

Many unconsidered claims are made for the advantages of intermodulation methods of testing, not the least of which is the "added sensitivity". An unthinking glance at the power series expansion of the transfer characteristic of an amplifier with two signals applied simultaneously is the main cause of this (see Appendix). At first sight the coefficient of the second order intermodulation component appears to be double the equivalent component for the second harmonic term. In point of fact it is, if the amplitudes of the signals "P" and "Q" are each the same as in the single signal case. In order to be fair to the equipment under test, however, it is essential to keep the peak-to-peak voltage applied the same as it would be with a single signal. The necessity for stressing this point is underlined by the current practice of quoting an amplifier specification in terms of harmonic distortion at a specific output power with a single signal applied, e.g. 10 watts at 0.1% distortion is a typical claim for a first-class audio amplifier. This claim may generally be substantiated at mid-band with a single signal. However, if two equal signals are applied and their level adjusted, so that the output is 10W, the distortion, both harmonic and inter-modulation, is found to have increased considerably and the output waveform, viewed on an oscilloscope, shows that overloading is taking place. In fact the peak-to-peak voltage swing has increased by 41.4%. From this it is obvious that any system which is to give results directly comparable with those obtained by simple harmonic methods must ensure that the peak-to-peak voltage is the same so that the same portion of the transfer characteristic is explored in each case.

Having this criterion in mind it is now possible to assess the relative sensitivities of the simple harmonic measurement method and the two inter-

Table 1. Relative sensitivities of harmonic C.C.I.F. and S.M.P.T.E. measurements

	Harmonic	C.C.I.F.	S.M.P.T.E.
Applied signal	"P" amplitude 10 units	"P" amplitude 5 units "Q" amplitude 5 units	"P" amplitude 2 units "Q" amplitude 8 units
2nd order term	$\frac{1}{2}a_2P^2 = 50\,a_2$	$a_2PQ = 25\,a_2$	$a_2\,PQ = 16\,a_2$
3rd order term	$\frac{1}{4}a_3P^3 = 250\,a_3$	$\frac{3}{4}P^2Q = 93.75\,a_3$	$\frac{3}{4}PQ^2 = 96\,a_3$
4th order term	$\frac{1}{8}a_4P^4 = 1250\,a_4$	$\frac{3}{8}\,a_4P^2Q^2 = 234.4\,a_4$	$\frac{1}{2}a_4PQ^3 = 512\,a_4$
Proportionate measurement 2nd	5	2.5	8
3rd	25	9.375	48
4th	125	23.44	256

These results have been simplified so as to indicate clearly the proportionate sensitivities. A more precise evaluation of the coefficients should take the higher order contributions into account[3]. (i.e., The second harmonic term is influenced by all even order terms and the 3rd harmonic by all odd order terms). However the additions due to these components do not affect the ratio appreciably.

modulation methods when using a wave analyser (Table 1). In each case the coefficient has been calculated by substituting suitable amplitude signals "P" and "Q" into the expression giving the frequency component being measured. These coefficients have then been referred to the composite signal level which may be applied to the wave analyser without introducing appreciable distortion. Thus in the case of harmonic distortion and of the C.C.I.F. system, the coefficient has been referred to 10 units. In the S.M.P.T.E. case, the coefficient has been referred to 2 units. This is permissible as the system used includes a band stop filter tuned to the low frequency signal "Q", thus ensuring that no intermodulation can take place in the wave analyser. From these figures it will be seen that the S.M.P.T.E. method is the most sensitive and the C.C.I.F. system the least.

Practical Results

Table 1 indicates that the results obtained by the three different methods should be directly comparable. A series of tests has been carried out to determine how nearly this is true in practice.

The first amplifier tested was a wide-band transistor amplifier in which careful attention had been given to the frequency/amplifier characteristic, but no emphasis at all placed on the distortion. The results are shown in Table 2. By multiplying the intermodulation distortion results with the ratio between the corresponding coefficients given in Table 1 to convert the results to those which would be obtained by simple harmonic analysis methods, it is seen that, within the limits of experimental error, Table 1 appears to be correct.

In view of the good correlation between theory and practice in the first test, a series of tests was made on an amplifier which was deliberately designed to have a poor inherent frequency characteristic similar to that of a cheap domestic radio receiver. In order to obtain reasonable results, the signal level was kept well below the overload point. The results of the tests are shown in Table 3. It is immediately apparent from these that the simple correlation between the three test methods no longer holds. Both intermodulation methods show more even-order distortion and less odd-order than would be expected. To a large extent this may be accounted for by recognising the fact that the frequency characteristic is non-linear and that therefore the coefficients a_1, a_2 etc. are frequency dependent. However, a full mathematical analysis to show that this is the case is both complex and tedious.

In an attempt to improve the distortion characteristic, 26dB of negative feedback was applied to the amplifier. The result was a reduction in both the harmonic distortion and even-order intermodulation products. The odd-order products increased so that they were in fact worse with feed-back than without.

In the hope that the readings taken in the last set of tests are peculiar to poor quality amplifiers, a proprietary 10W amplifier with a 0.1% distortion claim was tested. The results are shown in Table 4. It will be seen from these results that again there is no correlation at all between the measured results and the coefficients given in Table 1.

The study of the results obtained in the three series of measurements indicates that there is no simple rule for making distortion measurements.

Table 2. Measurements on a "flat" amplifier using the three methods

Harmonic method "P" = 1V	Fundamental freq.	2nd harmonic	3rd harmonic	4th harmonic
	1 kc/s	0.3%	0.1%	0.005%
	10 kc/s	0.25%	0.1%	0.005%
S.M.P.T.E.				
P = 0.2V at 10 kc/s	2nd order term at 9 kc/s = $0.49\% \times \frac{5}{8} = 0.31\%$			
Q = 0.8V at 1 kc/s	3rd order term at 8 kc/s = $0.18\% \times \frac{25}{48} = 0.094\%$			
	4th order term at 7 kc/s = $0.12\% \times \frac{125}{256} = 0.0058\%$			
C.C.I.F.				
P = 0.5V at 10 kc/s	2nd order term at 1 kc/s = $0.14\% \times \frac{5}{2.5} = 0.28\%$			
Q = 0.5V at 9 kc/s	3rd order term at 8 kc/s = $0.035\% \times \frac{25}{9.375} = 0.093\%$			
	4th order term at 9 kc/s = too small to measure.			

Table 3. Measurements on a poor quality amplifier

Fundamental	2nd harmonic	3rd harmonic	4th harmonic
Harmonic method			
60 c/s	0.72%	0.65%	0.05%
1 kc/s	0.4%	0.08%	<0.01%
10 kc/s	1.7%	0.1%	<0.01%
S.M.P.T.E.	2nd order term	3rd order term	4th order term
60 c/s + 1 kc/s	2.8%	0.05%	0.005%
60 c/s + 10 kc/s	9.5%	0.1%	0.006%
1 kc/s + 10 kc/s	4%	0.025%	0.005%
C.C.I.F.			
1.1 kc/s + 900 c/s	1.1%	0.012%	0.009%
10.5 kc/s + 9.5 kc/s	6.5%	0.01%	0.01%

Table 4. Measurements on a "quality" amplifier

Fundamental	2nd harmonic	3rd harmonic	4th harmonic
Harmonic method			
60 c/s	0.4%	0.3%	0.1%
1 kc/s	0.1%	0.25%	0.04%
10 kc/s	0.45%	0.62%	0.08%
S.M.P.T.E.	2nd order term	3rd order term	4th order term
60 c/s + 1 kc/s	0.1%	0.45%	0.02%
60 c/s + 10 kc/s	0.25%	0.62%	0.005%
C.C.I.F.			
1.1 kc/s + 900 c/s	0.03%	0.12%	—
10.5 kc/s + 9.5 kc/s	0.07%	0.12%	—

Each case must be treated individually on its merits and one or more test methods applied. Simple harmonic measurements suffice in most cases but where a measurement is to be made either of extremely low distortion (e.g. less than 0.03%) or at the upper frequency limit of an amplifier, intermodulation methods are invaluable. The general rules for intermodulation measurement are:—

1. The peak-to-peak input voltage should be the same as that used for simple harmonic measurement.
2. All the frequencies involved in the measurement should be within the pass band of the equipment under test, e.g. there would be no point in measuring the intermodulation introduced by a tweeter loudspeaker using a signal of 60 c/s for the l.f. signal in an S.M.P.T.E. test.
3. The test signals should be combined in such a

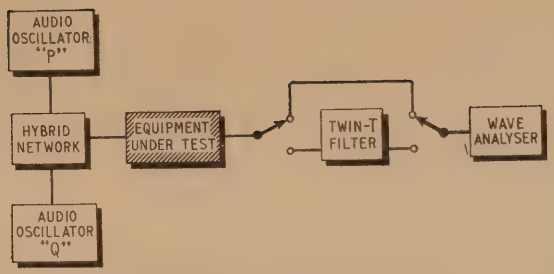


Fig. 4. Intermodulation test arrangement using a wave analyser.

manner that there is negligible inherent intermodulation.

4. If at all possible, one or both of the test signals should be excluded from active portions of the measuring equipment.

Test Equipment

The test arrangement used is shown in Fig. 4. As there is no need for extreme purity of the output from the signal generators "P" and "Q", any suitable audio oscillators may be used, provided a simple resistive hybrid network is employed to combine the two signals. However, in the experiments described two Marconi Instruments audio frequency signal sources Type TF 2000 were used. With these oscillators the isolation within the intruments is sufficient to permit the outputs to be connected in parallel without introducing any measurable intermodulation. Thus it was possible to dispense with the hybrid network. The band stop filter was a simple RC twin-T network designed to have maximum rejection at 60 c/s which was the low frequency used in all the S.M.P.T.E. measurements. The wave analyser was a Marconi Instruments Type TF 2330. The selectivity of this instrument is such as to permit reasonably accurate measurements of 0.03% 60 c/s side bands, thus making these tests possible.

APPENDIX

The transfer function of an amplifier may be written as:—

$$V_{out} = a_1V + a_2V^2 + a_3V^3 \ldots\ldots\ldots\ldots a_nV^n$$

If a signal $V = P\sin pt$ is applied, the expression may be expanded as follows:—

$$\begin{aligned}
V_{out} = {} & \tfrac{1}{2}a_2P^2 + \tfrac{3}{8}a_4P^4 \ldots\ldots\ldots\ldots \\
& + (a_1P + \tfrac{3}{4}a_3P^3 \ldots\ldots)\cos pt \text{ (FUNDAMENTAL)} \\
& + (\tfrac{1}{2}a_2P^2 + \tfrac{1}{2}a_4P^4 \ldots\ldots)\cos 2pt \text{ (2nd HARMONIC)} \\
& + (\tfrac{1}{4}a_3P^3 \ldots\ldots\ldots\ldots)\cos 3pt \text{ (3rd HARMONIC)} \\
& + (\tfrac{1}{8}a_4P^4 \ldots\ldots\ldots\ldots)\cos 4pt \text{ (4th HARMONIC)}
\end{aligned}$$

If two signals $V_1 = (P\sin pt + Q\sin qt)$ are applied, the expression may be expanded as follows:—

$$\begin{aligned}
V_{out} = {} & \tfrac{1}{2}a_2P^2 + \tfrac{1}{2}a_2Q^2 + \tfrac{3}{8}a_4P^4 + \tfrac{3}{8}a_4Q^4 + \tfrac{3}{4}a_4P^2Q^2 \\
& + (a_1P + \tfrac{3}{4}a_3P^3 + \tfrac{3}{2}a_3PQ^2 + \quad \ldots)\cos pt \\
& + (a_1Q + \tfrac{3}{4}a_3Q^3 + \tfrac{3}{2}a_3P^2Q + \quad \ldots)\cos qt \\
& + (\tfrac{1}{2}a_2P^2 + \tfrac{1}{2}a_4P^4 + \tfrac{3}{4}a_4P^2Q^2 \quad \ldots\ldots)\cos 2pt \\
& + (\tfrac{1}{2}a_2Q^2 + \tfrac{1}{2}a_4P^4 + \tfrac{3}{4}a_4P^2Q^2 \quad \ldots\ldots)\cos 2qt \\
& + (\tfrac{1}{4}a_3P^3 \quad \ldots\ldots\ldots\ldots\ldots)\cos 3pt \\
& + (\tfrac{1}{4}a_3Q^3 \quad \ldots\ldots\ldots\ldots\ldots)\cos 3qt \\
& + (\tfrac{1}{8}a_4P^4 \quad \ldots\ldots\ldots\ldots\ldots)\cos 4pt \\
& + (\tfrac{1}{8}a_4Q^4 \quad \ldots\ldots\ldots\ldots\ldots)\cos 4qt \\
& + (a_2PQ + \tfrac{3}{4}a_4P^3Q + \tfrac{3}{2}a_4PQ^3 \ldots\ldots)\cos (p+q)t \quad \text{(s)} \\
& + (a_2PQ + \tfrac{3}{4}a_4P^3Q + \tfrac{3}{2}a_4PQ^3 \ldots\ldots)\cos (p-q)t \quad \text{(c) (s)} \\
& + (\tfrac{3}{4}a_3P^2Q \quad \ldots\ldots\ldots\ldots\ldots)\cos (2p+q)t \text{ (c)} \\
& + (\tfrac{3}{4}a_3P^2Q \quad \ldots\ldots\ldots\ldots\ldots)\cos (2p-q)t \text{ (c)} \\
& + (\tfrac{3}{4}a_3PQ^2 \quad \ldots\ldots\ldots\ldots\ldots)\cos (p+2q)t \text{ (s)} \\
& + (\tfrac{3}{4}a_3PQ^2 \quad \ldots\ldots\ldots\ldots\ldots)\cos (p-2q)t \text{ (s)} \\
& + (\tfrac{3}{8}a_4P^2Q^2 \quad \ldots\ldots\ldots\ldots\ldots)\cos 2(p+q)t \\
& + (\tfrac{3}{8}a_4P^2Q^2 \quad \ldots\ldots\ldots\ldots\ldots)\cos 2(p-q)t \text{ (c)} \\
& + (\tfrac{1}{2}a_4P^3Q \quad \ldots\ldots\ldots\ldots\ldots)\cos (3p+q)t \\
& + (\tfrac{1}{2}a_4P^3Q \quad \ldots\ldots\ldots\ldots\ldots)\cos (3p-q)t \\
& + (\tfrac{1}{2}a_4PQ^3 \quad \ldots\ldots\ldots\ldots\ldots)\cos (p+3q)t \text{ (s)} \\
& + (\tfrac{1}{2}a_4PQ^3 \quad \ldots\ldots\ldots\ldots\ldots)\cos (p-3q)t \text{ (s)}
\end{aligned}$$

(s) = Component measured by S.M.P.T.E. system.
(c) = Component measured by C.C.I.F. system.

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(1) Scott, H. H., "Audible Audio Distortion." *Electronics* 18.1. (January 1945), P. 126.
(2) Hilliard, J. K. "Intermodulation Testing" *Electronics* 19.7 (July 1946), P. 123.
(3) Callendar, M. V., and Matthews, S. "Relations Between Amplitudes of Harmonics and Intermodulation Frequencies." *Electronic Engineering*, June 1951, P. 230.

RADIO TRADERS' CONFERENCE

TOPICS discussed at this year's annual conference of the Radio and Television Retailers' Association ranged from the pros and cons of resale price maintenance to the technical problems of expanding the B.B.C.'s television services.

In a talk on the B.B.C.'s new television programme, Mr. Leonard Miall, the assistant controller of television programme services, spoke on the problems of creating BBC-2. To give some indication of the size of the task, Mr. Miall said the B.B.C. had to recruit and train 1,200 people for engineering duties. Re-equipping the studios and o.b. units was another major task and to date 91 extra television cameras and 500 television monitors have been installed for the new programme. Mr. L. W. Turner, head of the B.B.C.'s engineering information department, assisted Mr. Miall in answering delegates' questions, one of which was "When will Devon and Cornwall get colour television?"!

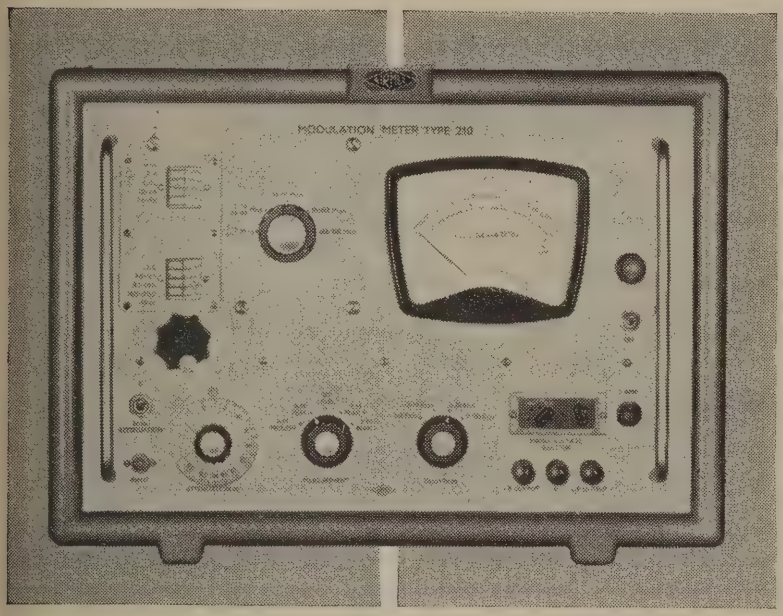
Mr. Miall said the postponement of colour television to 1967 has been a disappointment to the Corporation, especially when countries like Japan already have three colour services. However, the B.B.C. expected to be able to provide viewers in the present BBC-2 service area with colour during 1967 and, in other areas, colour television will arrive with the extension of BBC-2.

The fact that wired television relay systems are becoming popular and threaten the livelihood of dealers in areas where these systems are planned or are already in operation was among several interesting points raised at the conference. Mr. Michael Keegan, the Association's director, said that, with one exception, all the recent new town projects have accepted systems from the relay companies. The only solution he had to offer was that dealers should inform their local authorities that communal aerial systems are available and are equally competitive. After all, with the communal aerial system the viewer does have the opportunity of choosing any brand of receiver.

Sir Ian Orr-Ewing, M.P., was a guest speaker in the R.P.M. debate. After answering many varied questions Sir Ian said that he was confident that honest traders have nothing to fear from the R.P.M. Bill.

tune . . . set level . . . select AM or FM

*for **instant direct reading** of Modulation Depth or Deviation*



- **Carrier Frequency** 2.25–600 Mc/s.
- **AM** 0–100%, peak or trough.
- **FM** 0–100 Kc/s in 4 ranges, +ve or –ve peak.

Throughout its extensive measuring range, the Airmec Modulation Meter Type 210 has the sensitivity to handle low signal input levels. It will accurately measure AM inputs from 7mV to 700mV, and FM inputs from 7mV to 10V.

Monitor outputs of both LF and IF are available at front panel terminals. The IF output is at 750 k/cs, and allows the modulation envelope of the input signal to be observed on an oscilloscope.

Limiting action is so effective that spurious frequency modulations on AM signals can be measured. Changes of mean carrier level when amplitude modulation is applied can also be measured to an accuracy of better than ± 1%

Airmec Modulation Meter Type 210

Airmec for peak performance consistently

LABORATORY INSTRUMENTS DIVISION—
High Speed Counters, Signal Generators, Oscilloscopes, Wave Analysers, Phase Meters, Ohmmeters, Valve Voltmeters etc.
AIRMEC LIMITED · HIGH WYCOMBE · BUCKS · ENGLAND
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AP281

9WW—100 FOR FURTHER DETAILS.

Marconi Self-Tuning H.F System
—the first in the world to be station planned from input to output

MST

breakthrough

MST 7½kW transmitter H1100 series

An h.f linear amplifier transmitter for high-grade telecommunications.
Frequency range: H1100 and H1101, 4—27.5 Mc/s
H1102 and H1103, 2—27.5 Mc/s
Output power: 7—8 kW p.e.p, 5—6 kW c.w.
The H1100 series meets all CCIR Recommendations.

saves 85% floor space

Transmitters can be mounted side by side and back to back or against a wall; built-in cooling fan; no external air-ducts. These features lead to smaller, simpler, cheaper buildings or more services in existing buildings.

simplicity

R.F circuits have only three tuning controls and two range switches. Final valve can be replaced in 30 seconds. Miniature circuit breakers (used instead of fuses throughout) can be reset instantly. All sub-assemblies are easily tested because they are electrically complete units.

rugged reliability

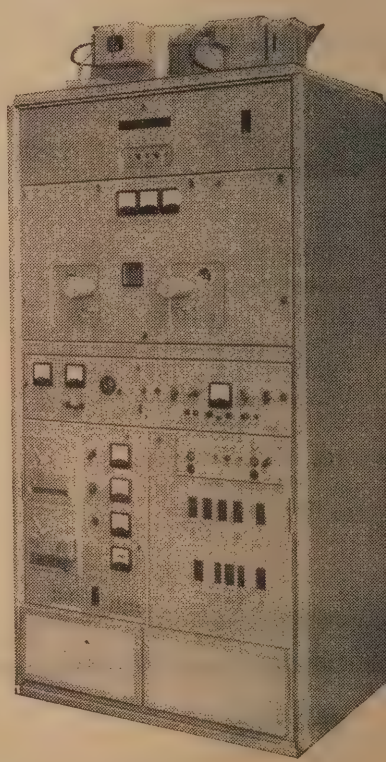
Stainless steel shafts in ball-bearings in rigid machined castings; stainless steel spur gears meshing with silicon bronze; heavy r.f coil contacts with high contact pressure—some examples of design features giving long term endurance and operational reliability. Specified performance achieved with ample margins.

self-tuning

Types H1101 and H1103, used with MST drive equipment, give *one-man* control of an entire transmitting station and continuous automatic aerial loading.

MANUAL TUNING

Manually tuned versions, types H1100 and H1102, are available which, when fitted with built-in drive units, become entirely self-contained transmitters for four spot frequencies and all types of modulation.
Manual tuning takes less than 60 seconds.



Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England LTD/H50

9WW—101 FOR FURTHER DETAILS.

DOMESTIC RECEIVERS AND TAPE RECORDERS AT HANOVER FAIR

ALTHOUGH it is barely eight months since we last reported on developments in the west German radio industry the visit to last month's Hanover Fair was well worth while. Traditionally, the Fair marks the opening of the new season's sales campaigns, and most receiver manufacturers had on show their completed range of 1964/65 sets. New trends were to be seen in television, radio and tape recording, not only in styling but also in technical details.

Television:—The sales departments of most firms are making capital out of the increasing use of transistors in German sets today. Some have as many as 14 and few less than 5 in the front-end tuners and i.f. amplifiers. It is suggested that reliability is increased by as many times as there are transistors. However that may be, some of the associated circuits, particularly in the i.f. stages, are extremely interesting. Both Grundig and Imperial now use etched foil i.f. stages with unscreened printed flat spiral coils tuned, in the case of Imperial, by conventional screwed cylindrical ferrite cores, but in the Grundig sets by ferrite discs. The advantage of these is that it is possible to find only one maximum setting. The printed circuit board is a plug-in unit with edgewise contacts along the lower side.

In Graetz sets the line output stage is mounted on a plug-in printed board. A four-stage all-transistor i.f. amplifier is favoured by Graetz with two gain-controlled AF181s followed by two AF121s. All transistors are plug-in and easily replaceable and the wide-band coupling transformers are unusual in form, being toroidal-wound on ferrite cylinders.

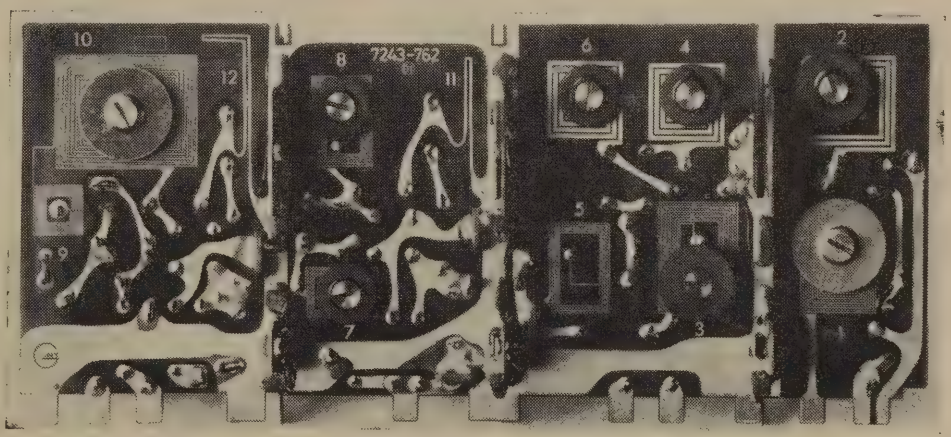
Single-knob tuning for both v.h.f. and u.h.f. with a continuous long scale and automatic waverange switching is a feature of the new Normende sets and in the capacitance-touch motor-controlled version ("Tippomatic") transistors are now used in the control circuits.

Blaupunkt, who came out with a long horizontal cabinet styling at the Berlin Show last autumn have carried the process a stage further in their "Bayreuth" television-stereo-radio-gramophone by providing an end compartment into which the television tube can be folded down and out of sight. A hinged flap gives a smooth table top to the stereo cabinet, outside viewing hours.

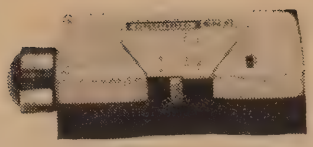
Radio:—Although medium-priced table-model sound broadcast receivers are still to be found in makers' ranges they are rapidly giving place to the general-purpose transistor portable which can be used as a home receiver and for picnics. Performance is being improved in two respects—quality of reproduction, and sensitivity. The Körting Type 25 064 for example has an unusually large loudspeaker and with 1.5W output stage gives "*Konzert*" performance. In this set there are parallel two-bar ferrite aerials in addition to a telescopic aerial for v.h.f. and press-button a.f.c. for final tuning when a station has been found. The Philips "Nicolette" has also been given a larger loudspeaker and the Normende "Globetrotter," Saba "Transeuropa Automatic" and Telefunken "Bajazzo TS" share in setting the trend not only in improved radio and audio performance, but in the rectilinear styling in black and chromium.

Stereo broadcasting is having a little more success in Germany than in the U.K. and several of the *Länder* broadcasting organizations are putting out regular if limited test transmissions. All leading manufacturers now market stereo adapters, and the aerial manufacturers have not been slow in producing the higher-gain Band II aerials which can also discriminate against possible multi-path propagation troubles.

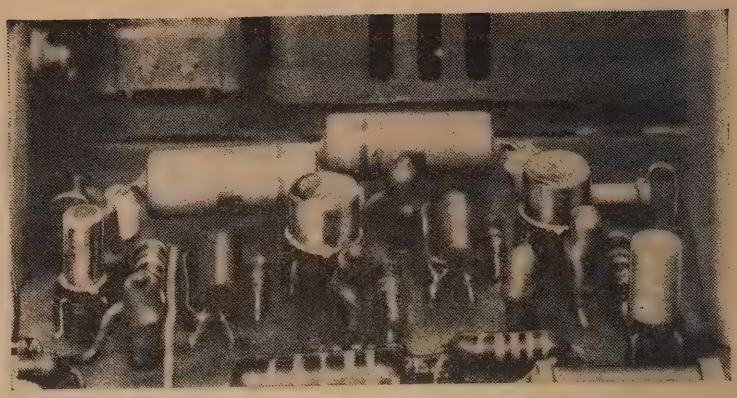
Tape Recorders:—A combined record player and medium-wave broadcast receiver little bigger than the normal car radio has been produced by Saba and is known as the "Sabamobil." When reception is noisy or the programme not to his taste the car driver can, single-handed, slip in a tape cassette and enjoy a programme of his own choice. Saba are producing their own recordings through the firm of



Printed i.f. amplifier (including coils) in the T400 series Grundig television receivers. The loops marked 11 and 12 are for neutralizing.

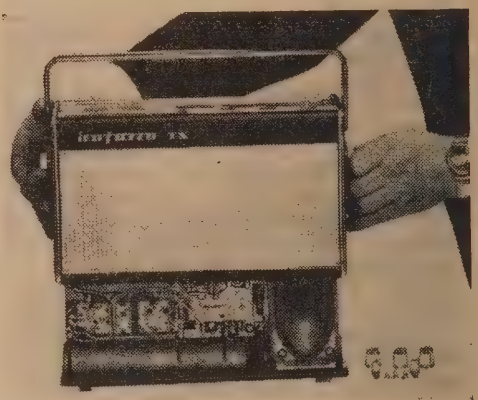


▲ *Grundig Type EN3 "electronic notebook" measures $5\frac{1}{4} \times 2\frac{1}{2} \times 1\frac{1}{2}$in.*

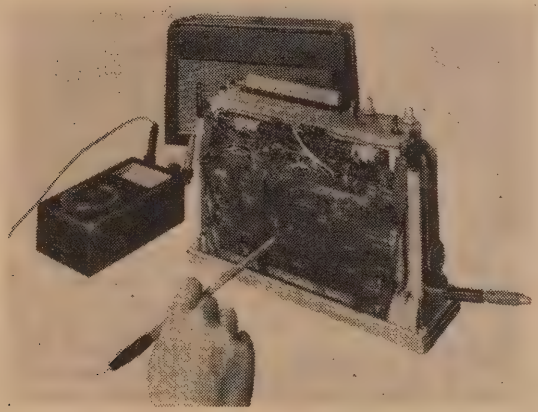


▲ *Toroidal ferrite-cored transformers are used in Graetz wide-band television i.f. amplifiers.*

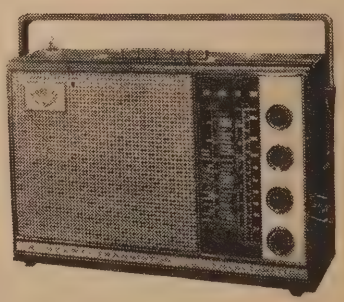
▲ *Blaupunkt "Bayreuth" television-stereo-radio-gramophone. The c.r.t. display folds back into a horizontal position when not required.*



▲ *Telefunken "Bajazzo TS" portable is designed for ease of servicing.*



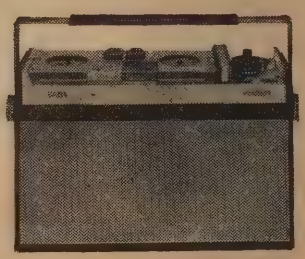
▲ *Paper masks are provided for locating test points in Graetz printed circuit receivers (in this case the "Super Page").*

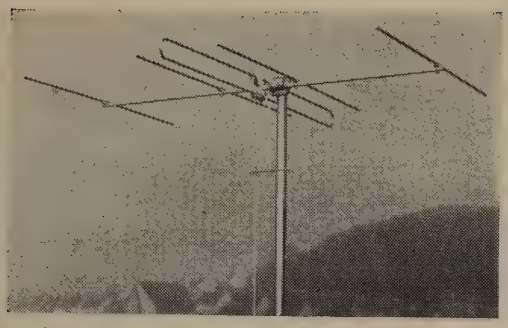


◀ *Körting Type 25 064 transistor portable with 1.5W output stage.*

◀ *Philips 3300 tape recorder in special mounting for car use.*

▶ *"Sabamobil" combined medium-wave car radio and tape record player.*

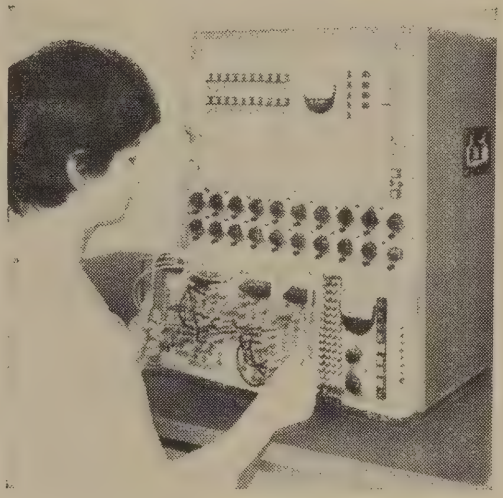




▲ *Bi-directional high-gain aerial (UKA Stereo 33) for Band II by Fuba.*

▲ *Siemens high-gain Band II aerial, Type SAA 164.*

▲ *Equipment by Grundig for talking along a light beam*



▲ *Telefunken Type RAT 740 analogue computer.*

Ariolo and the tapes on 7-cm spools are 170 metres in length and have four tracks giving a total playing time of 2 hours per cassette at a tape speed of 9.5 cm/sec ($3\frac{3}{4}$in/sec). Power output into the built-in loudspeaker is 3 watts, but 10 watts is available for use with an extension loudspeaker.

Philips, also, were featuring their Type 3300 pocket tape recorder in a special mounting for motorists which enables them to pull out or retract, with a lever action, a tray under the dashboard. The driver can record verbal notes or dictate letters as well as playing back recordings of his choice.

Most compact of all is the new Grundig "Electronic Notebook" (Type EN3) which is a complete battery-operated recorder (with playback) measuring $5\frac{1}{4}$in × $2\frac{1}{2}$ × $1\frac{1}{2}$ and weighing only $13\frac{1}{2}$oz. The moving coil microphone serves also as a playback loudspeaker. Playing time is about 45 minutes and erasure is by permanent magnet; there is no h.f. bias. The $4\frac{1}{2}$ volt batteries last about 15 hours.

Also remarkably compact for its type is the new automatic telephone answering machine developed by Graetz. Measuring only 7in × $3\frac{1}{2}$ × $10\frac{1}{2}$in it gives a preliminary announcement of 12 seconds and then permits the caller a 30 second message.

Styling in tape recorders, like that of portables is acquiring the "technical look" i.e. the appearance of a measuring instrument rather than a piece of weekend luggage. Notable examples are the Telefunken "100" series and the Uher "4000 Report-S."

In conclusion we have space to mention two eye-catching electronic demonstrations.

One is the Grundig light-beam communication system in which a light bulb is modulated directly by a.f. between 300 and 2800 c/s and the received signal is converted by a photodiode and amplified.

The other is the Telefunken RAT 740 analogue computer which was demonstrated in process of solving a problem in the springing of an automobile. To show that the capacity of the machine was not overtaxed by this exercise, the remaining functions were used to draw-in on the face of the c.r.t. the outline of a Volkswagen, which duly responded to simulated road shocks.

I.E.A. EXHIBITION GUIDE

THE fifth in the series of Instruments, Electronics & Automation Exhibitions opens at Olympia, London, on May 25th for six days. Sponsored by five industrial associations* it will be by far the largest in the series and has attracted well over 600 firms, about a fifth of them from overseas.

The interests of the exhibitors are very diverse—from raw materials to elaborate automation systems—and the large majority of them produce equipment which falls within the purview of *Wireless World*.

It will be obvious, therefore, that it is impossible to deal adequately in a few pages with so vast a display of products many of which are being seen for the first time at a public exhibition in this country. However, in the following pages we have endeavoured to give readers a brief preview of the exhibition compiled from information which manufacturers were invited to send. Not all exhibitors responded to the invitation and some who did were showing equipment on the fringe of *W.W.* interests.

Many of the exhibitors listed below are sharing stands. It has been necessary, therefore, to group them together stand-by-stand. To facilitate the finding of references in this preview we have included in the list of exhibitors the name, in square brackets, under which the report on the stand is listed. Where we have thought it might be useful we have appended a number for use on the reply card by professional readers requiring further information on manufacturers' exhibits. We hope to publish a further report in the next issue after members of *Wireless World* staff have visited the stands.

* British Electrical & Allied Manufacturers' Association, British Industrial Measuring & Control Apparatus Manufacturers' Association, Electronic Engineering Association, Radio & Electronic Component Manufacturers' Federation and the Scientific Instrument Manufacturers' Association.

LIST OF EXHIBITORS

Exhibitor	Stand No.
A.D.S. Relays	E259
A.E.I.	G78
A.E.P.-International	N431
A.K. Fans	N169
AMF	G396
A.P.T. Electronic Indus.	G385
Acbars	N184
Accles & Pollock	E523
Ad. Auriema	N422
Addo	N157
Advance Electronics	E286
Advanced Products Co.	G12
Air Control Installations	E292
Aircraft-Marine Products	N203
Airflow Developments	G354
Airmec	G74
Allspeeds	N425
Alma Components	G377
Alston Capacitors [Alma]	G377
American S.T. Wires [S.A.S.C.O.]	E566
Ampex Great Britain	G64
Amphenol-Borg	G18
Analytical Measurements	E257
Ancillary Developments	E525
Anderton Springs	N209
Anglo-German Translation	G130
Arclex	G12
Aric	E287
Arrow Electric Switches	G112
Asch Equipment Co.	N438
Ashcroft Dewrance Inst. Co.	E542
Assoc. Automation [Elliott] E255 &	G50
Associated Iliffe Press	N408
Assoc. des Ouvriers en Inst. [Lyons]	G117
Astralux Dynamics	E517
Ateliers de Construction [Solartron]	G77
Atkins, Robertson & Whiteford [Scott]	G121
Aumann K.G. [Cole Electronics]	N409
Austen Pumps	G110A
Automat Precision Eng. AG	N438
Autronic Developments	N195
Aveley Electric	E265
Avery, W. & T.	G48
Avo	N176
BEME Telecoms. [Derritron]	N429
B.F.I. Electronics	G61
BICC-Burndy	N175
B.I. Callender's Cables	N175
B. & K. Laboratories	G85
B. & R. Relays	G88
Bailey Meters & Controls	G46
Baird-Atomic [Wood]	G131
Bakelite	E521
Baldwin Inst. Co. [Elliott] E255 &	G50
Balzers High Vacuum	N403
Barden Corp.	E272
Barr & Stroud	E536
Bay & Co.	E508
Bay State Electronics [A.E.P.]	N431
Beckman Instruments	G47
Bedco	G22A
Belclere Co.	G375
Belix Co.	E530
Bell & Howell	N437
Belling & Lee	G54
Bellingham & Stanley	N167
Bendix Electronics	N205
Benson-Lehner	E526A
Bernstein-Werk. [D.T.V.]	N197
Beulah Electronics [D.T.V.]	N197
Blakeborough, J. & Sons	N199
Bogen, W. [Cole Electronics]	N409
Bourns Inc. [Painton]	E261
Bowmar Instrument	G391
Bradley, G. & E. [Lucas]	G72
Bran & Leubbe (G.B.)	E275
Brayhead [Ancillary Dev.]	E525
Bribond Printed Circuits	G384
Brimar Indust. Valves	G27
Bristols Inst. Co.[Elliott] E255 &	G50
Britimpex	E560
British Aircraft Corp.	G98
British Drug Houses	E520
British Electric Resistance Co.	E251
British Ermeto Corp.	G125
British Iron & Steel Res.	N440
British Physical Labs.	N156
British Rototherm Co.	G373
Brown, Neville, & Co.	N414
Brown, S. G.	N170
Brush Clevite Co.	E289
Bryans	G106
Budgen Instruments	E276
Budenberg Gauge Co.	E266
Bulgin, A. F. & Co.	G83
Burgess Products Co.	G89
Bush Beach & Segner Bayley	G383
C. & N. (Electrical)	E522
C.R.E.I. (London)	E506
C.T. (London)	E501
C. Z. Scientific Inst.	N182
Cambion Electronic Prod.	E545
Cannon Electric (G.B.)	N413
Carr Fastener Co.	N190
Cathodeon Crystals [Pye]	E270
Celdis	G86
Censor Patent [Joseph Electronics]	N402
Central Dynamics [A.E.P.]	N431
Chatillon & Sons Inc.	N438
Ciba (A.R.L.)	E293
Clare, C.P. [Elliott] E255 &	G50
Clarke, H. & Co.	G90
Cobham, Alan, Engineering	G99
Cohu Electronics [Solartron]	G77
Cole, R. H., Electronics	N409
Colliery Guardian Co.	G382
Colvern	G356
Combustion Instruments	G368
Comoy, H., & Co.	E534
Compagnie des Compteurs	E544
Computer Controls Ltd.	N193
Connollys (Blackley)	E262
Constructions Radioelectriques et Electroniques [Lyons]	G117
Continental Connectors	N208
Contraves A.G.	N193
Cossor Group	G30
Costruzione Radioelettriche [Lyons]	G117
Coulter Electronics	N417
Counting Instruments	E252
Cressall Manufacturing Co.	N196
Crompton Parkinson	G22
Crosby Valve & Eng. Co.	N151
Crossley, Henry	G12
Croven [A.E.P.]	N431
Croydon Precision Inst. Co.	G367
Cryotronics Inc.	N195
Cybernetic Developments [A.P.T.]	G385
D.E.V. Engineering	N161
D.S.I.R.	G40
D.T.V. Group	N197
Dage (Great Britain)	E501
Data Recording Instrument Co.	E512
Dawe Instruments	N423
Davis Emergency Equip.	N438
Day, J. & Co.	G11
Day, P. G. [Kerry's]	N160
Daystrom Inc. [Solartron]	G77
Daystrom	G391A
De La Rue Frigistor	N428
Defense Electronics [A.E.P.]	N431
Degenhardt & Co.	E551
Degussa Hanau	G383
Delta Controls	E274
Delviljem (London)	G108
Demornay-Bonardi Corp.	E501
Den Norske Hoyttalerfabrikk [DNH]	G128
Derritron Group	N429
Deuta-Werke	E513
Devar Controls [Elliott] E255 &	G50
Devices Sales	G96
Digital Equipment Corp.	G398
Digital Measurements	E562
Diodes Inc.	E501
Dobbie McInnes	N198
Drayton Controls	G49
Du Pont Co.	E553
Dubilier Condenser Co.	G25
Dürrwächter - Doduco - K.G. [Joseph Electronics]	N402
E-A Tech. Services [Elliott] E255 &	G50
EFEN Elektrotechnische	E267
ERG Elektro-Röhren	E267
Eberle & Co.	E267
Ediswan Industrial Tubes	G27
Ekco Electronics	G71
Elcom (Northampton)	N426
Electrical Develop. Assoc.	N187
Electrical Remote Control Co.	G93
Electrical Times	E295
Electro Mech. Res. [Solartron]	G77
Electro Mechanisms	N400
Electroflo Meters [Elliott] E255 &	G50
Electrolube	N207
Electronic Associates	N177
Electronic Instruments	G355
Electronic Machine Co.	N152
Electronics & Automation [Palmer]	G353
Electrons Inc. [Lyons]	G117
Electrosil	E557
Electrothermal Engineering	G87
Electrovac [Joseph Electronics]	N402
Electroweighers (Birmingham)	N168
Elesta Electronics	E564
Elga Products	E509
Elliott Group E255 &	G50
Emeco Electronics [Palmer]	G353
Engelhard Industries	E278
English Electric Co.	G69
English Electric Valve Co.	G62
English Numbering Machines	G35
Entech	G399
Epsylon Industries	G26
Erg Industrial Corp.	G374
Ericsson [Plessey]	G68
Erie Resistor	G350
Ether	G51
Europa Engineering Co.	E558
Evans Electroselenium	G17
Evershed & Vignoles	G53

Exhibitor	Stand No.
Fabrique Maret	E561
Facit	G393
Fairchild Publications	N420
Fairey Engineering	E281
Faraday Electronic Inst. [Beckman]	G47
Farnell Instruments	E524
Farris Engineering [Elliott]	E255 & G50
Feinmechanik und Optik	G95
Ferranti	G79
Fielden Electronics	G38
Fieldtech [Bendix]	N205
Filhol, J. P.	G101
Fischer & Porter	E254
Fleming Instruments	G371
Flexonics [Electro Mech.]	N400
Formica	E555
Foster Instrument Co.	N159
Fox, P. X. [General Controls]	G116
Foxboro-Yoxall	G56
Frako GmbH	E267
Friden	E285
Furzehill Labs.	N206
G.E.C. (Electronics)	G70
G.E.C. (Telecommunications) [M-O Valve]	E288
G.K.N. Screws & Fasteners	E282
G.P.O.	G357
General Applied Science Labs. [A.E.P.]	N431
General Controls	G116
General Radio Co. [Lyons]	G117
Glass Developments [Ultrasonoscope]	E518
Gloster Equipment	G55
Gloucester Controls	N436
Goodmans Industries	G107
Gordon & Co. [Elliott]	E255 & G50
Gordon Valves [Elliott]	E255 & G50
Graphic Instruments	E276
Graviner Manufacturing Co	N211
Greibech Insts. Corp [Lyons]	G117
Gresham Lion Electronics	N424
Gudenbrod Bros. Silk Co.	G12
H.C.D. Research	E505
H.V.L. S.A.	G359
Haddon & Stokes [G.K.N.]	E282
Haefner & Krullmann [Cole Electronics]	N409
Hahn Magnet	E267
Hallam, Sleigh & Cheston	G28
Hallikainen Instruments [Elliott]	E255 & G50
Hamilton (Instrumentation)	E561
Harris Plating Works	E258
Harwin Engineers	G91
Hassett & Harper	N191
Hatfield Instruments	N210
Hawker Siddeley Dynamics	G390
Hawksley & Sons [Beckman]	G47
Headland Engineering Dev.	G351
Hellermann Equipment	E548
Hendrey Relays	G378
Hengstler, J., Co.	E514
Henley Inc.	E501
Henry & Thomas	G360
Hewlett-Packard	N174
Hexcel Products Inc.	G12
Heywood & Co.	E532
Highland Electronics	G127
Hirschmann, Richard	E267
Hirst Electronic	E503
Hivac	N171
Hoffmann	E516
Honeywell Controls	N188
Horizon House Inc.	G397
Hughes International	G366
Hunt, A. H.	G31
Hunt & Mitton	G15
I.E.C. (Electronics)	N438
Ide, T. & W.	G119
Ilford	E284
Imhof	G379
Impectron [Ad. Auriema]	N422
Industrial Pyrometer Co.	N443
Infotronics Corp. [Techmation]	N432
Instron	E263
Instruments & Communications [Techmation]	N432
International Electro-Comp.	E501
International Electronics	E552
International Engineering	N438
International Res. & Dev.	N441
International Systems Control [G.E.C.]	G70
Ireland Industrial Dev.	N442
Isora Illuminating Ceilings [Electro Mechanisms]	N400
Japan Electron Optics Lab.	G108
Jautz, Karl, GmbH	E267
Jenaer Glaswerk Schott & Gen.	N427
Jennings Radio Mfg. Corp.	G359A
Joclin Manufacturing Co.	G12
Johnson, Matthey & Co.	N433
Joseph Electronics	N402
K.D.G. Instruments	E264
K. & N. Electronics	E539
KOVO	E269
Kappa Electronics	G369
Kent, George	G39
Kent Mouldings [S.T.C.]	G66
Kerry's (Ultrasonics)	N160
Ketay [Plessey]	G68
Keyswitch Relays	E547
Kings Electronics [S.A.S.C.O.]	E566
Knott Elektronik [A.E.P.]	N431
Kuhnke, H.	E515
Kumag A.G. [Cole Electronics]	N409
Kynmore Engineering Co.	N193
L.P.S. Electrical [Day]	G11
Laboratoire Electro-Acoustique [Furzehill]	N206
Laboratoire Industriel d' Electronique Belin [Solartron]	G77
Laboratoires de Physique Applique [Solartron]	G77
Laboratory for Electronics [Scott]	G121
Lancashire Dynamo	G122
Landis & Gyr	E531
Langendorf Watch Co.	E561
Lectropon	G60
Leeds Meter Co.	N181
Leeds & Northrup	N162
Leesona Holt	E554
Leevers-Rich Equipment	E541
Levell Electronics	E268
Leybold-Elliott [Elliott-Automation]	E255 & G50
Linvar	G20
Lippke, Paul, K.G.	E275
Livingston Laboratories	G84
Lloyd & Hillman	G401
Lloyds Bank	E256
Londex [Elliott-Automation]	E255 & G50
London Elect. Wire Co. & Smiths	N410
Lucas, Joseph	G72
Lufthansa German Airlines	G350A
Lund Bros. & Co.	E565
Lyons, Claude	G117
M.B. Metals	G394
M.C.P. Electronics [Reliance Controls]	N404
M.E.L. Equipment Co.	G82 & G114
M-O Valve Co.	E288
Magnetic Devices	N164
Magnetic & Electrical Alloys [Telcon]	N183
Maier, Karl	E267
Malaker Laboratories Inc.	N195
Mallory Batteries	G58
Manigley Frères	E561
Marconi [English Electric]	G69
Marconi Instruments	N189
Markovits, I.	G21
Marrison & Catherall	G372
Martin-Ivo	G129
Mason, E. N., & Sons	G395
Mawdsley's	G361
Mazda Equipment Sales Dept.	G27
McMichael [G.E.C.]	G70
McMurdo Instrument Co.	G103
Measuring Instruments [Pullin]	G44
Mec-Test	N166
Medintron	G360
Mercantile Credit Co.	E502
Metal Detection	N168
Meterflow [S.E. Labs.]	G63
Metrimpex	E526
Microcell	G94
Micronia Amplifier [Lyons]	G117
Microponent Development	N434
MicroTek Instruments [Techmation]	N432
Microtube S.A.	E561
Midland Bank	N200
Millivac Instruments [Lyons]	G117
Milton Ross Co.	E563
Mine Safety Appliances Co.	G92
Miniature Bearings	N438
Miniature Electronic Comps.	G43
Mining & Chemical Prods. [Reliance Controls]	N404
Ministry of Aviation	N172
Ministry of Defence	N172
Model & Prototype Systems	N213
Moore, Reed & Co.	E519
Morgan Bros.	N163
Morganite Resistors	N185
Motorola Semiconductor Prods.	G86
Muirhead & Co.	G32
Mullard	G37
Murex	N406
N S F	N407
Nalder Bros. & Thompson	E253
Negretti & Zambra	G73
Neoflex	E267
New Western (Engineering)	G73
Newmark, Louis [McMurdo]	G103
Newmarket Transistors [Pye]	E270
Newport Instruments	N195
Non - Linear Systems [A.E.P.]	N431
Norgren, C.A.	N192
Nuclear Enterprises (G.B.)	E250
Oliver Pell Control	G386
O.M.I. Instruments [Palmer]	G353
Optical Works	G14
P & H Engineering Co.	E260
P.S.B. Instruments	N415
Pacific Semiconductors [Reliance Controls]	N404
Packard Instruments	N430
Painton & Co.	E261
Palatine [Elliott-Automation]	E255 & G50
Pall Corp.	G12
Pall (U.K.)	G401
Palmer, G.A. Stanley	G353
Panax [Electronic Machine]	N152
Paramatic Engineering	G100
Parechoc S.A.	E561
Parkinson Cowan Measurement	G29
Parmeko	G42
Payne & Griffiths	N212
Pedoka	N439
Pergamon Press	G352
Perkin-Elmer	N401
Philbrick Res. Inc. [A.E.P.]	N431
Phoenix Telephones	N444
Photoelectronics Holdings	G59
Pignone Sud S.p.A.	G389
Plannair	N418
Platon, G.A.	G13
Plessey Co.	G68
Polaron Instruments	G108
Potter Instrument Co.	N432A
Printed Circuits [LEWCOS]	N410
Publishers' Association	E550
Pullin, R. B., & Co.	G44
Pulsonic [Derritron]	N429
Pye Group	E270
Pyro-Werk GmbH	E556
Quentin & Cie [Solartron]	G77
RCA Great Britain	G364
Raaco	E510
Racal Instruments	N173
Radiatron	E511
Radionic Products [S.A.S.C.O.]	E566
Rank Organisation	G45
Rathdown Industries	E543
Record Electrical Co.	E500
Recording Instruments Group	E276
Reliance Controls	N404
Reliance Cords & Cables	N180
Reliance Gear Co.	N419
Research Controls Inc. [Platon]	G13
Reslosound [Derritron]	N429
Reuter-Stokes Electronic Components [A.E.P.]	N431
Rivlin Instruments	N153
Roband Electronics	N186
Robinson, F. C., & Partners [Hunt]	G31
Rochar Electronique [Solartron]	G77
Rose Bros. (Gainsborough)	G12
Ross, Courtney & Co.	N405
Rotameter Manfg. [Elliott]	E255 & G50
Rotax [Lucas]	G72
Rotron Controls [Elliott]	E255 & G50
Roulements Miniatures S.A.	N438
Royal Worcester	G362
Royce Electric Furnaces	E291
Royston Instruments	G10
Rustrak Instruments	E290
S.E. Laboratories (Engineering)	G63
SESCO [Reliance Controls]	N404
SFIM [Electro Mechanisms]	N400
SGS-Fairchild	N412
Salford [M-O Valve]	E288
Salter & Co.	E296
Sanders Group	G388
Sangamo Weston	G75
Scama	E549
Schaevitz Eng. [Electro Mechanisms]	N400
Schlumberger [Solartron]	G77
Schnorr, Adolf, K.G.	N438
Schnyder-Liechti, S.A.	E561
Scott, James	G121
Sealectro Corp. [Elga]	E509
Self Organizing Systems [S.A.S.C.O.]	E566
Semiconductors [Plessey]	G68
Semikron M.B.H. [H.C.D. Research]	E505
Service Electric Co.	G19
Servo Consultants	E538
Seton Creaghe Engineering	N438
Sferax S.A.	N438
Shandon Scientific Co.	G392
Shaw Publishing Co.	N445
Siemens & Halske [Cole Electronics]	N409
Sierex	E535
Sifam Electrical Instrument Co.	N420
Simplifix Couplings	G125
Singer Co. [Electro Mechanisms]	N400
Sirco Controls	G97
S. London Electrical Equip.	G115
Smith, S., & Sons (England)	N202
Société Analac [Lyons]	G117
Société d'Electronique Materiel Automatique Controle [Solartron]	G77
Société d'Instrumentation Schlumberger [Solartron]	G77
Solartron Electronic Group	G77
Sorensen-Ardag	E501
Southern Instruments	G49
Sovirel	N150
Spear Engineering Co.	G370
Sperry Gyroscope Co.	E273
Spirol Pins	E561
Standard Telephones & Cables	G66
Stanton Instruments	G105
Steatite Insulations	G104
Stewart Aeronautical Supply Co.	E566
Stratton & Co.	E279
Studer S.A.	E561
Superior Electric Nederland	G126
Swartwout [Elliott-Automation]	E255&G50
Swiss Jewel Co.	G12
Swiss Instruments & Comps.	G400
Sylvania International	N411
Sylvania-Thorn	G27
Symonds Engineering Co.	G12
Symonds, R. H.	G12
Synchronome Co.	E264
System Computers	N441
TRG Inc [Lyons]	G117
TRW Semiconductors [Reliance Controls]	N404

Exhibitor	Stand No.
Tannoy Products	E527
Taylor Instrument Co.	G65
Techmation	N432
Techna (Sales)	G363
Technivision Group	G387
Technograph & Telegraph	N155
Tectonic	N421
Teddington Aircraft Controls	E546
Tektronix U.K.	G67
Telcon Metals	N183
Teledictor	G111
Telefunken [Britimpex]	E560
Telegraph Condenser Co.	G36
Telehoist [Wayne Kerr]	G34
Telektron (Great Britain)	E528
Telephone Manufacturing Co.	G81
Telequipment	G109
Temco [Telcon Metals]	N183
Texas Instruments	G52
Thermal Syndicate	G358
Thermionic Products [Airmec]	G74
Thompson, J. Langham [Ether]	G51
Thorn-AEI Radio Valves & Tubes	G27
Thorn Electronics	G118& E271
Tinsley & Co.	N158
Tintometer	G110
Tiro-Clas S.A.	E513
Tolana S.A. [Solartron]	G77
Toolpro [Telcon Metals]	N183
Topper Cases	G24
Tothill Press	G120
Transitron Electronic	N179
Trumeter Co.	E294
Turbo-Werk Köln	G399
Turner Electrical Inst.	G23
Turton Bros. & Matthews	G41
20th Century Electronics	G380
Tylors	N161
U.S. Business Inform. Center	E507
Ultra Electronics	G80
Ultrasonoscope Co.	E518
Uni-Tubes [Smiths]	N202
Union Carbide	N435
Union Optical Co. of Japan	G108
United Electric Controls [A.E.P.]	N431
United Trade Press	G376
Vactite Wire Co. [LEWCOS]	N410
Vactric Control Equipment	N178
Vacwell Eng. [Electronic Machine]	N152
Varad Inc. [Lyons]	G117
Varian Associates	N154
Veeco Instruments	E504
Veeder-Root	G16
Venner Electronics	G76
Vero Electronics	E529
Victoreen Instrument [A.E.P.]	N431
Vidor Corp. [A.E.P.]	N431
Visual Engineers	G73
Wandleside Cable Works	E559
Watch Stones	E561
Waters Manufacturing Inc.	N438
Waycom	E537
Wayne Kerr Labs.	G34
Weber [Cole Electronics]	N409
Welmec Corp.	G123
Welwyn Electric	G365
West Instrument	E290
Westinghouse Brake & Signal Co	N165
Westminster Bank	E283
Westool	N194
Whiteley Electrical Radio Co.	N201
Williams & James (Engineers)	E280
Wire Products & Machine Designs	G113
Wireless World	N408
Witte & Sutor [Joseph Electronics]	N402
Woden Transformer Co.	E277
Wood, Hugh, & Son	G131
X-Lon Products	N416
Yellow Springs Inst. [S.A.S.C.O.]	E566
Zeal, G. H.	E533
Zenith Electric [Lyons]	G117

PREVIEW OF I.E.A. EXHIBITS

A.D.S. RELAYS

Their complete range of relays is being shown this year. In addition to the Post Office 3000 and 600 types, a selection of miniature units—some measuring as little as $\frac{7}{8}$ in cube—are on display.

9WW 301 for further details

A.E.I.

A large selection of products from Associated Electrical Industries electronics group are featured. A.E.I.'s closed-circuit television system (which can be run off two 12V car batteries), a range of silicon and germanium rectifier diodes, a high-speed motor uniselector and a representative range of relays are included in the display. The radio component department's display includes transistor mounting pads and holders, coaxial attenuator plugs, printed circuit connectors, and a new 5mm plug and socket system.

9WW 302 for further details

A.E.P.

A.E.P.-International Ltd. are showing a selection of products from a number of overseas companies, including a pulse height analysing computer from the American Victoreen Instrument Company, a sweep signal generator from the Bay State Electronics Corp., a large-screen oscilloscope—with plug-in units—from Knott Elektronik and statistical digital voltmeters from Non-Linear Systems.

9WW 303 for further details

A.K. FANS

In addition to the Airmax range of fans manufactured by A.K. Fans Ltd., a selection of fans made by the Rotron Manufacturing Corporation are on show. Other exhibits include forced convection heat sinks and subminiature Minicube blowers.

9WW 304 for further details

A.M.P.

"Circuitip" terminals, printed circuit edge connectors, test probe receptacles, re-usable component jacks, plugs and sockets, modular connectors and neon pilot indicators are among this year's exhibits.

9WW 305 for further details

A.P.T.

The data processing division of A.P.T. Electronic Industries Ltd. is showing a range of plug-in electronic drive and logic circuits which it has designed for coupling paper tape and card readers to electric typewriters. Other exhibits include a selection of power supplies, heat sinks and blower units. Language laboratory equipment from Cybernetic Developments Ltd. is also being shown.

9WW 306 for further details

AD. AURIEMA and IMPECTRON

The two companies on this stand represent well over 50 overseas manufacturers. Components, laboratory equipment and domestic radio equipment can be seen.

9WW 307 for further details

ADVANCE

Advance Electronics Ltd. (until recently Advance Components) is showing items from its range of instruments, including the SC1 20 kc/s counter, PG54 transistor pulse generator, SG21 v.h.f. square-wave generator, and the OS41 single-beam oscilloscope. The bandwidth of this scope is d.c. to 22 Mc/s, with a maximum sensitivity of 50 mV/cm (or 5 mV/cm from 10 c/s to 18 Mc/s using the switchable pre-amplifier).

9WW 308 for further details

AIR CONTROL INSTALLATIONS

A selection of axial and centrifugal blowers, with impellers ranging from $1\frac{1}{2}$ to 8in in diameter, are shown together with a number of miniature filters. Arrangements can be made with the manufacturers to borrow these units on free loan for development purposes.

9WW 309 for further details

AIRFLOW DEVELOPMENTS

Among the air and gas flow test equipment on show is a transistorized anemometer.

9WW 310 for further details

AIRMEC

The full range of Airmec instrumentation is shown. This includes voltmeters, signal generators and the recently introduced u.h.f. instrumentation. Thermionic Products is sharing the stand and is showing a new range of magnetic, tape-recording equipment, which includes a 7-track analogue recorder, an 8-track digital recorder and tape-transport mechanisms. Other equipments demonstrated are a speaking clock, standard tape transport operating from a 24 V direct supply with an inverter and a standard Series IV communications recorder.

9WW 311 for further details

ALMA

Alma Components Ltd. are showing a comprehensive selection of their resistors, including their new ranges of precision metal film resistors. Alma are also showing a range of dry reed and mercury wetted relays. Other exhibits include a selection of capacitors from Alston Capacitors Ltd. In addition to the established type approved CMM1-G and CMM3-Y silvered mica capacitors, a new range is being shown for the first time.

9WW 312 for further details

AMPHENOL-BORG

Amphenol-Borg (Electronics) Ltd. are displaying a variety of connectors, and crimp contact demonstrations are being given daily. A full range of potentiometers are also being shown.

9WW 313 for further details

ANCILLARY DEVELOPMENTS

Ancillary Developments, exhibiting for the first time, are showing flux-

sensitive heads for data-recording applications, precision gear heads and clutch-brake mechanisms, miniature trimmers, differential potentiometers, sub-miniature variable resistors and servo potentiometers.
9WW 314 for further details

ARROW ELECTRIC SWITCHES
Sub-miniature as well as the standard range of Arrow switches are being displayed. A small relay with open and closed circuit combinations up to 8 poles rated at 10 amps at 250 V a.c. is also shown.
9WW 315 for further details

AVELEY ELECTRIC
Equipment manufactured by Rohde and Schwarz, Fairchild International, Brush Instruments, Norda, North Atlantic, Stoddart, and Scientific Atlanta is displayed. The range includes oscilloscopes, impedance-measuring instruments, coaxial connectors and semiconductor testers with digital readout.
9WW 316 for further details

AVO
A comprehensive selection of "Avo-Meters," including the Mk. 3 version of the Model 8, valve characteristic meters and transistor analysers are being shown with a selection of nucleonic instruments. A new oscilloscope camera, which is a joint product of Avo and the Beattie-Coleman Inc. of California, is also exhibited.
9WW 317 for further details

B.I.C.C.
British Insulated Callender's Cables Ltd. are showing a comprehensive range of cables and accessories. A substantial proportion of the display is devoted to exhibits of B.I.C.C.-Burndy Ltd., which include a variety of connectors. Most of these employ compression jointing techniques.
9WW 318 for further details

B.I.S.R.A.
The British Iron and Steel Research Association is demonstrating an inductive loop data transmission system as applied to an overhead crane. It is also showing several items of automation equipment and instrumentation relative to the iron and steel industries.

B & K LABORATORIES
Components and instruments with applications in all engineering fields are shown. Ultrasonic systems, high-voltage components, welding-control apparatus and general electronic instrumentation are being demonstrated.
9WW 319 for further details

B & R RELAYS
In addition to their own range of electro-mechanical relays and allied equipment, B & R Relays Ltd. are also showing Siemens & Halske miniature relays, Adlake mercury wetted and mercury displacement relays and Benedikt & Jäger contactors. B & R are showing a miniature 3-pole changeover plug-in relay and a transistor timing unit for the first time at this year's show.
9WW 320 for further details

BAKELITE
Two recently introduced grades of glass laminates, one based on melamine resin, the other on epoxide glass, are being shown with the more conventional laminates based on paper, wood, fabric and asbestos. One of the principal exhibits is a borrowed computer unit, incorporating printed circuitry based on copper-clad Bakelite laminations.
9WW 321 for further details

BARDEN
In addition to showing a selection of precision ball bearings, the Barden Corporation (U.K.) Ltd. is exhibiting a bearing torque testing instrument and a Smoothrator; an electronic instrument used to check performance qualities of oil lubricated ball bearings, by revealing their vibrational characteristics.
9WW 322 for further details

BARR & STROUD
The principal electronic exhibit is a transistor image-orthicon television camera similar to the ones used in the periscope television systems installed at the Winfrith reactor station. Other exhibits include a Morse automatic keying device, standard ruby, neodymium and gas lasers as well as a variety of mirrors, crystals and other components. Optical components are also being shown.
9WW 323 for further details

BECKMAN INSTRUMENTS
A number of new products are being displayed. These include a pH meter designed primarily for research work, a range of British manufactured pH electrodes and a radioactivity counting system. The Helipot Division are demonstrating their Hall-effect voltage generators. In addition to the new equipments the established range of Beckman analytical and electronic components will be shown.
9WW 324 for further details

BELLING-LEE
Among the selection of components from a range of over 1,000 are several new items including the one-hole-fixing series of Securex miniature circuit breakers, a new-style flexible terminal block with stainless steel pressure pads to accommodate a wide range of wire gauges, and a range of pattern 15(B.N.C.) connectors. The Prestincert system of component mounting is featured.
9WW 325 for further details

BENDIX
As well as U.K.-manufactured products Bendix are showing equipment from their parent and associated companies. Among the new items are a rotary pulse generator for deriving pulses from a rotating shaft, a digital integrator, a tester for measuring the leakage and gain characteristics of both p-n-p and n-p-n transistors and a digital voltmeter measuring 100μV to 1,000 V d.c. in five ranges.
9WW 326 for further details

BENSON-LEHNER
A variety of digital shaft coders are being shown. Other exhibits include an incremental plotter, which is on show for the first time, and an electroplotter, a machine which can produce "report-quality" graphs rapidly and accurately from computer-generated output data.
9WW 327 for further details

BERCO
The British Electric Resistance Company is showing its range of Bercotrol solid-state automatic control units. These units, which have ratings from 3 to 39A a.c., operate from 250-volt single-phase a.c. mains supplies and will provide either d.c. or a.c. outputs. "CVS" (continuous voltage stabilizers) and regulating transformers are also being shown.
9WW 328 for further details

BRIBOND PRINTED CIRCUITS
A comprehensive selection of printed circuit boards in current use, including examples of precious metal plating and roller tin coating, are being shown. Their latest roller tin coating machine, the Brilite, is also displayed along with samples of their specialized lines, which include thermocouples, flexible circuits and cableforms.
9WW 329 for further details

BRITISH PHYSICAL LABS
The major exhibit is the multi-stage component testing machine, Model A III, which is being demonstrated testing various parameters of metallized plastic-foil capacitors, at the rate of 3,500 per hour. B.P.L.'s new deviation voltmeter, Model DM164-L, and their transistor voltmeter, can also be seen.
9WW 330 for further details

BRITIMPEX
Telefunken's U.K. distributors, Britimpex Ltd., are showing a wide selection of Telefunken products. These range from film resistors and polystyrene capacitors to miniature thyratrons and other special purpose valves. Among the other exhibits are transistor u.h.f. tuners, cathode ray tubes and several new v.h.f./u.h.f. semiconductor devices, including some in planar, epitaxial and mesa design.
9WW 331 for further details

BROWN
The recently introduced "Diplomat" lightweight headset, using ceramic transducers and having a frequency response of 20-17,500 c/s, is among the headphones shown. These "Diplomat" phones are used in the "Personal Auditorium" unit providing individual adjustment for each earpiece.
9WW 332 for further details

BRUSH
Brush Clevite Co., formerly Brush Crystal Co., is exhibiting several

new ranges of planar Zener diodes, power rectifiers and silicon epitaxial planar transistors for the first time. The planar Zener diodes are claimed to offer lower temperature coefficients and operate at different spot voltages than the conventional Zener.
9WW 333 for further details

BRYANS
The high sensitivity plotting table Model 20170, the portable plotter 22016, digital data translator 20017/F, the "Digitima" digital clock 20128 and an automatic symbol writer are among this year's display. Other exhibits include a function generator fitted to an x-y plotter and a selection of pressure control and calibration equipment.
9WW 334 for further details

BULGIN
Among the new components being shown are an addition to the series of momentary action s.p. push-button switches, a new range of s.p. moulded panel-mounting switches, several new signal lamps, and a variety of control knobs. Bulgin are also showing a representative selection of their standard range of products.
9WW 335 for further details

C. & N.
The 7383 simulator for the functional testing of time-sequenced electro-mechanical control equipment is on show with other examples of the company's products including a transistor h.f. communications receiver.
9WW 336 for further details

C.R.E.I.
Examples of new lesson material C.R.E.I. (London) has produced for its 1964 Home Study Programme are being shown. Programmes include electronic engineering technology, automation, space data systems and spacecraft tracking and control.
9WW 337 for further details

CIBA (A.R.L.)
Examples of the many uses of Araldite epoxy resins are being shown, including those for potting electronic components and circuits. A section of the stand has been devoted to Araldite moulding powders and their use in the manufacture of miniature transformers, multi-point connectors and other components.
9WW 338 for further details

CARR FASTENER
Only a small selection of the company's 5,000 or more components is being shown, including the "Cinch" Greenline range of moulded-edge connectors, micro and slide switches, indicator lights, plugs and sockets, etc.
9WW 339 for further details

COLE (R.H.) ELECTRONICS
Telecommunications test gear, precision laboratory instruments, and a wide range of components and accessories from the German company Siemens & Halske are being shown.

Cossor CD100 solid-state modular oscilloscope. ◀

▲ *An octave band sound level meter from Dawe Instruments Ltd.*

◀ *Miniature reed relay (AB1434) of E.R.G. Industrial Corp.*

A coil-winding machine from Aumann, a riveting press from Kumag and a wire stripper from Fuchs are among the other exhibits.
9WW 340 for further details

COLVERN
A comprehensive selection of wire-wound potentiometers and variable resistors is being shown. A new 10-turn helical potentiometer with an integral watch face dial is included in the display.
9WW 341 for further details

COMBUSTION INSTRUMENTS
An electrical servo-operated micro-balance, designed for weighing objects down to a microgram, is being shown. No special vibration-free or temperature-controlled enclosure is needed with this instrument.
9WW 342 for further details

CONSOLIDATED ELECTRODYNAMICS
The main feature of the display is an advanced recording oscillograph Type 5-133. A direct-writing instrument, it can record 36 or 52 channels on the 12-in, light-sensitive paper. Chemical processing is not required. Many other facilities are provided.
9WW 343 for further details

COSSOR
The instrument, industrial control and telecommunication divisions are represented. Consequently oscilloscopes, pulse generators, v.h.f. radiotelephone equipment and motor-control equipment are demonstrated. The versatility of the Model CD100 oscilloscope series will be shown with plug-in units which include single and dual-trace wideband amplifiers, differential amplifier, sweep units and $x-y$ plotter unit.
9WW 344 for further details

COULTER
Particle counting and sizing instruments are a speciality of this company which is showing several new models.
9WW 345 for further details

CRESSAL
The Cressal Manufacturing Company is exhibiting a range of resistors and control equipment. Fixed and pre-set resistors, sliding and toroidal rheostats—with ratings up to 1,000 watts—are being shown with a selection of their Torovolt auto and double wound variable transformers. The Cressal system of electromagnetic screening using expanded metal mesh and specially designed filter units is also shown.
9WW 346 for further details

CROMPTON PARKINSON
Self-contained wattmeters, frequency indicators, static transducers and expanded-scale d.c. voltmeters are among the instruments being shown. Other interesting exhibits include pivotless movements in circular scale switchboard instruments, circular scale ohmmeters in desk stands for school bench use, and a new form of internal illumination for 2½in and 3½in instruments.
9WW 347 for further details

CROPICO
The Croydon Precision Instrument Company is showing a selection of

precision measuring instruments. Preferred value resistance boxes, Wheatstone bridges and insulation test sets are included in the display.
9WW 348 for further details

D.N.H.
A wide range of D.N.H. loudspeakers made by the Norwegian firm of Den Norske Høyttalerfabrikk is being shown by their U.K. representative Douglas A. Lyons & Associates. They are designed primarily for industrial and public address systems.
9WW 349 for further details

D.S.I.R.
Instruments developed by the D.S.I.R. or associated industrial research organizations are exhibited. The Electrical Research Assoc. is showing an instrument for calibrating any discharge detector which observes individual discharges using detection frequencies up to 2 Mc/s. The Motor Industry Research Assoc. has developed a torque measuring device employing f.m. telemetry. Semiconductor strain gauges are used in the small, easily handled tension meter devised by the Wool Industry Research Assoc.

D.T.V. GROUP
A low-priced transistorized closed-circuit television system, built to industrial standards, is featured together with the Beukit "do-it-yourself" television camera kit. A selection of the American EICO instrument kits are also being shown. These can be supplied ready-made.
9WW 350 for further details

DATA RECORDING
The Data Recording Instrument Company is exhibiting a number of new products from the range of magnetic recording equipment it manufactures for use in instrumentation, data processing and communications.
9WW 351 for further details

DAWE INSTRUMENTS
Five new instruments are being shown for the first time. These are: a transistor battery-operated sound level meter, an octave-band sound level meter, a vibration meter, an a.f. analyser with a frequency coverage of 2c/s-20kc/s, and a variable bandwidth filter.
9WW 352 for further details

DAY, J. & CO.
A comprehensive range of p.v.c. and polythene wires and cables are being shown. Many new types of subminiature and multicore cables are included in the display. Screened wires are also featured.
9WW 353 for further details

DAYSTROM
Subminiature potentiometers for computer and missile applications, servo components, resistors and bi-metal thermometers are among this year's exhibits. The Heathkit ranges of domestic and amateur radio equipment, audio equipment and test instruments are also being shown.
9WW 354 for further details

DERRITRON
The Derritron Group of companies is showing a wide variety of products this year ranging from Reslosound microphones and Chapman audio equipment to laboratory measuring instruments. A digital Wheatstone bridge and several potentiometers, decade boxes and voltmeters are included in the instrument display. Pulsonic welding and ultrasonic cleaning equipment is also being shown.
9WW 355 for further details

DIGITAL MEASUREMENTS
A comprehensive range of digital measuring equipment is exhibited. This includes digital voltmeters, multi-channel, digital-data recording systems with alarm-level monitoring, optical shaft encoders and precision a.c. dividers, etc. New accessories developed for the established equipments are also shown.
9WW 356 for further details

DOBBIE McINNES
Two twin-channel Graphispot recorders, the GRS and the GRD, are latest additions to the range of industrial and laboratory galvanometer recorders being displayed this year. Another instrument to be shown for the first time is the "D-Mac" limpet logger, a self-contained instrument used for sampling and recording data, at pre-set intervals, on magnetic tape
9WW 357 for further details

DUBILIER
Capacitors, resistors and suppression devices are being shown by the Dubilier Condenser Company. Products of interest include delay and pulse-forming networks, and a range of interference suppressors.
9WW 358 for further details

E.E.L.
Evans Electroselenium Ltd. is showing a selection from its range of E.E.L. photo-electric equipment for use in medical and industrial laboraties. A wide range of microammeters and galvanometer units are also displayed.
9WW 359 for further details

E.E. VALVE CO.
The English Electric Valve Company is showing a selection of the valves and tubes it manufactures for the electronics industry. The display includes high-power klystron amplifiers, storage tubes and television tubes as well as transmitting and receiving valves, travelling wave tubes, backward wave oscillators, etc. An entirely new series of high-voltage vacuum variable capacitors for 75A operation are also featured.
9WW 360 for further details

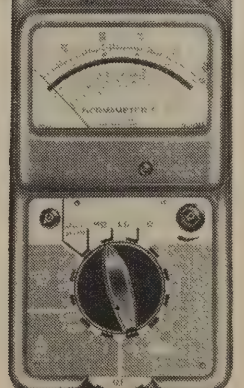
E.N.M.
English Numbering Machines Ltd. are exhibiting their wide range of mechanical and electro-mechanical counting devices and systems with indicating or print-out facilities.
9WW 361 for further details

E.R.G. INDUSTRIAL CORP.
A variety of chokes, transformers, resistors and dry reed relays are included in this year's display. The precision wire-wound resistors (to DEF 5113) are singled out as of special interest.
9WW 362 for further details

EKCO
Both the aviation and instrumentation divisions of Ekco are showing equipment including a radar speed meter for measuring the speed of moving vehicles and a miniature tuning fork, measuring $3 \times 2 \times \frac{7}{8}$in and available in a range of frequencies from 400c/s to 2.4kc/s. Dynatron equipment is also on show.
9WW 363 for further details

ELCOM
Elcom (Northampton) Ltd. are displaying their new range of sound mixing equipment and associated components, which include switches, plugs and sockets, printed circuit connectors, faders and attenuators. Complete mixing desks, ranging from four-channel transportable units to multi-channel consols are being shown.
9WW 364 for further details

▲ *The EICO 955 "in-circuit" bridge-type capacitor tester can be seen on the D.T.V. Group stand.*



▲ *Multirange meter Type 685-T shown by Cropico.*

ELECTRO MECHANISMS
A wide range of vibration transducers for flight-test instrumentation and ground-vibration analysis are shown and, in addition, the associated electronic equipment is demonstrated. Other exhibits include strain gauges, displacement transducers and a range of Japanese precision, wire-wound potentiometers.
9WW 365 for further details

ELECTROLUBE
The full range of Electrolube lubricants and greases are being shown together with examples of the components on which they are used.
9WW 366 for further details

ELECTRONIC MACHINE
Industrial electronic control equipment utilizing various types of capacity, photo electric and ultrasonic sensing devices is shown by Electronic Machine Control Ltd. And an extensive range of nucleonic instruments and equipment is being demonstrated by Panax Equipment Ltd. The other company in the Electronic Machine group, Vacwell Engineering, is showing specially manufactured equipment for setting up semiconductor production lines and full range testing of production batches of semiconductor devices.
9WW 367 for further details

ELECTROSIL
"Lo-cap" capacitors, with glass dielectric and fused into a glass monolithic unit in a range of 0.1 to 10pF, are featured together with a variety of resistors. Corning glass memories and thin film resistor networks are also to be seen.
9WW 368 for further details

ELECTROTHERMAL
The electronic division of Electrothermal Engineering Ltd. is showing a selection of moulded precision resistors, which the company introduced last year under the trade name Precistor. A selection of laboratory and industrial heating equipment, scientific instruments and control equipment is being shown by the company's heating division.
9WW 369 for further details

ELESTA ELECTRONICS
Included in the exhibits of this Swiss company are photoelectric devices, relays and electronic counters. Some of the cold cathode tubes they manufacture for stabilization, relay and counter applications are also being shown.
9WW 370 for further details

ELGA PRODUCTS
A new water-purification plant is introduced by Elga. Capable of being tailored to customer requirements, the basic system consists of the de-ionizer, control equipment (with quality monitor) and the distribution tank. An example of the scheme is that of the water requirement in a c.r.t. plant. Twenty-two "draw-off" points are provided, the system having a 500 gall/hr flowrate.

Sealectro Corporation is sharing this stand and are showing their vast range of Teflon-bodied terminals, coaxial cables and switches.
9WW 371 for further details

ELLIOTT-AUTOMATION
Products from more than 40 companies and divisions in the group are on show and it seems invidious to highlight any items. However, dominating their stand G50 is the display of the ARCH family of computing systems. There is also a demonstration of data transmission, examples of miniature logic elements, servo components, ultrasonic cleaning tanks, and digital recording and control systems. On stand E255 will be found a wide range of communications test instruments, precision microwave components and measuring instruments including some from Elliott's W. German associates Spinner and Wandel & Golterman.
9WW 372 for further details

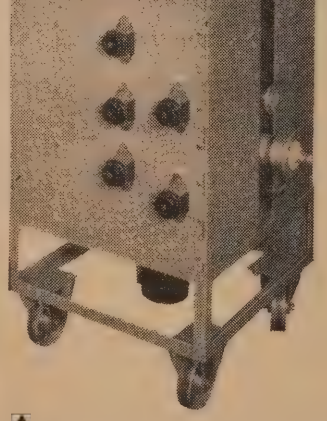
ENGELHARD
Engelhard Industries Ltd., who refine and fabricate precious metals, are showing a selection of their products. Thermocouples and measuring resistance wires are included along with a comprehensive display of hot-bonded bimetal rivets, which the company has introduced to counter the rising cost of silver.
9WW 373 for further details

ENGLISH ELECTRIC
Products from the Industrial Actuator Division, the Metal Industries Division, the Small Machines Division and the Fractional Horsepower Motor Division of the English Electric Company are shown. Demonstrations of telemetry, process control and marine watch-keeping systems are presented by English Electric-Leo Computers. This company also shows a number of photoelectric cells and infra-red detectors that were developed mainly for measurement applications in the steel industry.

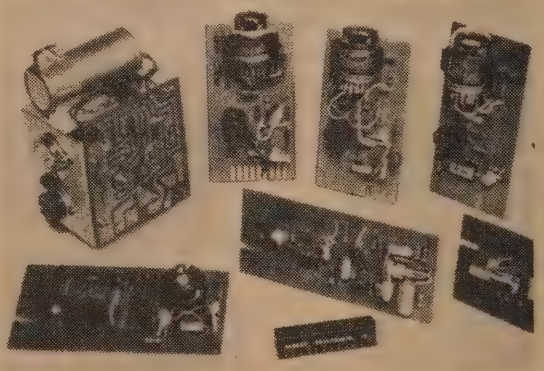
The principal demonstration in the Marconi Company's section of the stand is that of an ultra high-speed computer which performs over 30×10^6 orders per minute. Other demonstrations include "Autospec" error-correction equipment and closed-circuit television. Specialized components are also shown.
9WW 374 for further details

EPSYLON
Epsylon Industries are showing samples of magnetic recording equipment. The display includes four magnetic recorders introduced this year, their Series 111 lapped recording heads and their range of resistor

(*Continued on page* 285)



▲ *This 25kW power klystron (K377) from the English Electric Co. is to be used in the new BBC-2 television transmitters.*



▲ *These Panax sub-assemblies are being shown on the Electronic Machine stand.*

NUMBER ONE IN ELECTRICAL CONNECTORS... 1

2 OUTSTANDING CANNON® PLUG SERIES MEETING REQUIREMENTS OF MIL-C-26482C

KPT SOLDER POT

- SMOOTHER ENGAGEMENT AND SEPARATION FORCES, INHERENTLY PERFORMING IN A NARROWER RANGE, PROVIDED BY A REVOLUTIONARY BOWSPRING* SOCKET CONTACT DESIGN.
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- IMPROVED RELIABILITY BECAUSE OF SIMPLE ONE-PIECE MOULDED INSULATOR/GROMMET CONSTRUCTION —DUAL SHORE* OF SPECIALLY COMPOUNDED POLYCHLOROPRENE RUBBER.
- HIGHLY CONDUCTIVE LEADED-COPPER, PROBE-PROOF, CLOSED-ENTRY CONTACT HAS LOWER MILLIVOLT DROP PLUS MEETS REQUIREMENTS OF MIL-C-23216.
- INTEGRALLY-MOULDED POSITIVE STOP PREVENTS CONTACT OVER-INSERTION.
- DUAL SHORE INTEGRALLY-MOULDED INSULATOR/GROMMET FOR DEPENDABLE SEALING OF CONTACTS.
- RAISED BARRIERS AROUND EACH PIN, MATING WITH LEAD-IN CHAMFER AROUND SOCKET, PROVIDE INDIVIDUAL INTERFACIAL CONTACT SEALING.
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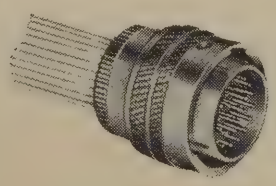
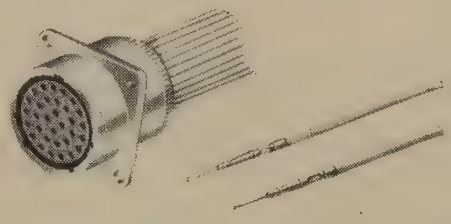
- SEALED IN TRANSPARENT, ENVIRONMENTAL PROOF BAG, WITH COMPLETE ASSEMBLY INSTRUCTION; CONTACTS, WITH SPARES, AND SEALING PLUGS PROTECTED IN SEPARATE VIAL.





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9WW—102 FOR FURTHER DETAILS.

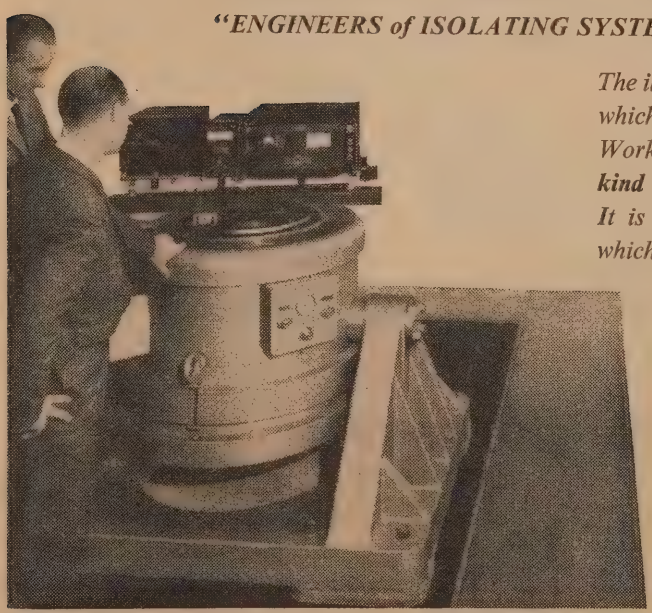
our concern is with "Q"

The transmissibility of a system at resonance is referred to as the "Q" of a system—a fact of which the vast majority of the readers of this Journal will be seized.

"Q" may be regarded as the measure of the efficiency with which our Isolators and Shockmounts function.

Many thousands of BARRYMOUNT Vibration and Shock Isolators are in service in aircraft on air routes all over the world. Similarly thousands of delicate instruments employed in fighting and other vehicles on land, and in ships at sea, are protected against shock and vibration by one or another of the various Isolators and Shockmounts which we design and manufacture. ***Increasingly they are being used in industry to protect modern control and recording equipment.***

Every engineer who is concerned with "Q" should have at hand a full set of these Product and Data Sheets . . . all you have to do is to write or telephone for our publication entitled "ENGINEERS of ISOLATING SYSTEMS".



The illustration (left) shows the large moving coil vibrator which is a unit of equipment in the Laboratories at our Works at Hersham; ***this is one of the largest units of its kind to be installed in an independent establishment.*** *It is typical of the resources we have developed with which we carry out environmental studies and testing.*

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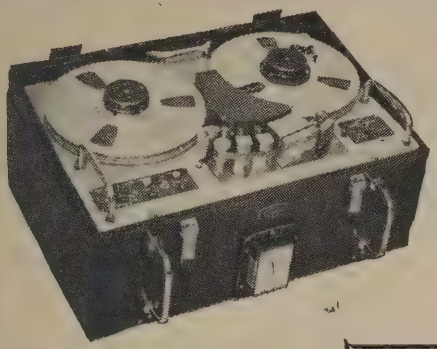
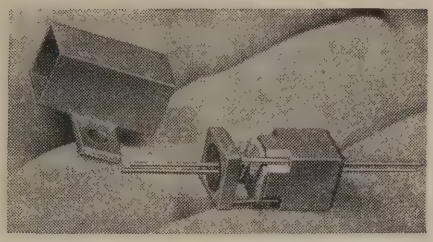


▲ *Epsylon MR1080 magnetic recorder for up to 16 channels.*



▲ *This miniature relay from G.E.C. (Telecommunications) can be seen on the M-O Valve stand.*

silicon transistor logic units ("Sylogs"). Closed-circuit television is also featured.
9WW 375 for further details

ERIE RESISTOR
Miniature tantalum capacitors suitable for working voltages of 6, 10, 15, 20, 35 and 50V (d.c.) are introduced. The capacitance range is 0.33 to 330μF. The established component lines are also shown. The miniature suppression filters demonstrated offer an attenuation of radio interference over a range of 150 kc/s to 1000 Mc/s.
9WW 376 for further details

ETHER
A thermocouple thermostat, a potentiometric indicating temperature controller, a precision 10-turn potentiometer, and a minature semiconductor strain gauge are among the exhibits to be seen for the first time. There are several working demonstrations incorporating temperature instruments, power supplies, solenoid valves, Haydon timers and transducers, etc.
9WW 377 for further details

EVERSHED
A series of solid-state circuit modules for on-line analogue computing are being demonstrated to show their use in industrial process control. Other exhibits include a selection of items from Evershed's range of instrumentation and control systems.
9WW 378 for further details

FACIT
Facit Aktiebolaget Atvidabergs Industrier of Stockholm, Sweden, are featuring three of their products at this year's show: the PE 1000 high-speed paper tape reader; the PE 1500 high-speed paper tape punch; and the Carousel magnetic tape memory. Both the tape reader and the tape punch are suitable for 5-, 6-, 7- or 8-track tape operation.
9WW 379 for further details

FAIREY GROUP
Companies within the Fairey Group are exhibiting a wide range of products. These include direct power converters, glove boxes and nuclear-control systems (all by the nuclear division), hydraulic devices and vibrators.
9WW 380 for further details

FARNELL
Several stabilized voltage supply units are being shown, including a number of new types, one of which, in addition to supplying an accurate voltage source, can be used to measure a voltage within the range 0-100 V at high accuracy. Farnell Instruments Ltd. are also showing a new low-priced sine and square wave oscillator, covering the frequency range 1 c/s to 100 kc/s.
9WW 381 for further details

FIELDEN
Fielden Electronics Ltd. are showing a wide selection of process control equipment. Other exhibits include a potentiometric pyrometer for use with thermocouples, a range of Bikini precision temperature controllers, and a low frequency alarm for use on 50 c/s and other supplies.
9WW 382 for further details

FILHOL
The exhibits include industrial jewel bearings, meter pivots, pins and sockets for multi-pin plugs and gramophone styli. The instrument parts supplied by this company are machined in many materials. Normally a 0.002in tolerance is maintained but, if required, the parts can be machined to within 0.0002in.
9WW 383 for further details

FORMICA
The full range of paper and glass-based, copper-clad laminates is displayed together with examples of printed circuitry constructed on typical laminates. Another display is devoted to the use of paper-fabric and glass-based industrial laminates. Engraved and printed signs (on Formica) are also shown.
9WW 384 for further details

FOSTER
A selection of temperature measuring and controlling equipment is being shown by the Foster Instrument Company. The display includes electrical resistance thermometers, thermo-electric, optical and radiational pyrometers.
9WW 385 for further details

FOXBORO-YOXALL
In addition to recent developments in the gas chromatography fields, the company's range of pneumatic and electronic analogue computers are shown. Other exhibits include flow meters and electronic and pneumatic force and motion balance transmitters.
9WW 386 for further details

FRIDEN
A desk-sized computer specially designed for applications which require high-speed computation as well as descriptive alphabetical information is shown. Other exhibits include a telephone data transmitting system, with complementary receiving equipment, and several calculators capable of automatic extraction of square roots and of automatic squaring.
9WW 387 for further details

G.E.C. ELECTRONICS
Data transmission equipment for sending information at 100 characters a second over telephone lines and incorporating error detection facilities is displayed. There are also four additions to the company's range of remote control and indication equipment. Also featured is the Lancon v.h.f. transceiver produced originally for the Lancashire Constabulary.
9WW 388 for further details

G.K.N.
The main feature of this stand is the range of G.K.N. Phillips "Pozidriv" recess screws. The advantages of the new shape (recess) are clearly shown by a colour film. Other products include weld bolts, crinkle washers and plastic mouldings.
9WW 389 for further details

G.P.O.
The data transmission service provided by the General Post Office is featured.

GENERAL CONTROLS
A complete range of precision wire-wound potentiometers and associated components are on display. Digital turns counters, indicating dials, precision turned knobs, locking control knobs, spindle locks and flush locks are also being shown.
9WW 390 for further details

GOODMANS
Loudspeakers from 2¼in to 12in diameter for domestic applications are being shown, with a selection of speaker enclosures. Goodmans Industries Ltd. are also showing a range of speakers for public address applications.
9WW 391 for further details

H.C.D. RESEARCH
Several frequency standards, one of which has an accuracy of better than one part in ten to the tenth per day, and precision oscillators are being shown. Other exhibits include ranges of selenium rectifiers, silicon diodes and encapsulated bridge rectifiers from their German associates Semikron.
9WW 392 for further details

H.V.L.
The Syntec 150 multi-channel pulse height analyser from Linear Alpha Inc. and the Model 400 channel height pulse analyser from Radiation Counter Laboratories Inc. are being displayed. H.V.L. Ltd. are also showing the Stabimat digital drift stabilizer and a selection of scintillation crystals from the Kyoto Electronics Manufacturing Company, of Japan.
9WW 393 for further details

HATFIELD
Hatfield Instruments and Balun Ltd. are showing their standard range of instruments, which includes an r.f. bridge, a selection of a.c. power supply units, and an a.c. clip-on milliammeter. Hatfield are also showing a range of transmission test equipment manufactured to designs of the G.E.C. Telecommunications Division. An industrial television camera manufactured by A.C.E.C. (Ateliers de Constructions Electriques de Charleroi) of Belgium, is also being shown.
9WW 394 for further details

HAWKER SIDDELEY
The industrial electronics division of Hawker Siddeley Dynamics Ltd. are showing the data handling equipment which forms the basis of their electronic control and telemetry systems. They also have a display showing the manufacturing techniques they use in the encapsulation of equipment.
9WW 395 for further details

HENDREY RELAYS
In addition to a comprehensive display of industrial and aircraft relays, complete systems for fire-prevention control and examples of special scientific equipment are shown.
9WW 396 for further details

HENGSTLER
A panel of electromagnetic counters provides an eye-catching display. The demonstration is programmed to show typical examples of the predetermining and indicating properties of the F043 and FA043 series of counters.
9WW 397 for further details

HEWLETT-PACKARD
A broadband frequency synthesizer (0.01 c/s-50 Mc/s), which employs a 1 Mc/s internal standard having a stability of ± 3 parts in 10^9 per day, a digital voltmeter and sweep oscillators for the 1-4 Gc/s range are among the new equipment being shown.
9WW 398 for further details

HIGHLAND ELECTRONICS
A range of miniature push-button switches, miniature rotary switches and specials, including spring-return, unidirectional and concentric, are being shown. Other exhibits include miniature balanced armature microphones and miniature alarms.
9WW 399 for further details

HOFFMANN
This Dutch company, which has now formed a British subsidiary—J. H. Hoffmann (G.B.) Ltd., specializes in the production of chart paper.
9WW 400 for further details

HIRST ELECTRONIC
The company's products to be seen include stabilized power supplies, and a display of encapsulated assemblies. As agents for Hughes Aircraft Co., of California, they are showing their micro-welding head with capacitor discharge power pack.
9WW 401 for further details

HIVAC
Recent additions to the company's range of thermionic and electronic devices being shown include the XN3 digital display indicator and dry reed relay inserts. They are also showing their range of subminiature valves.
9WW 402 for further details

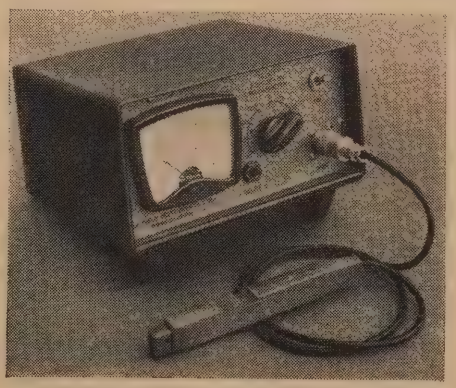
HONEYWELL
Items making their debut at the show include an on-line mass flow computer for measuring the flow rate of gases or liquids, an f.m. recorder/reproducer for the medical, scientific and industrial fields, and a 24-channel Visicorder oscillograph.
9WW 403 for further details

HUGHES INTERNATIONAL
Instruments and components are featured in this display. The components include a great variety of semiconductor devices and thermionic valves. The instruments include digital voltmeters, oscilloscopes and lasers. Welding equipment is also shown.
9WW 404 for further details

HUNT
All types of miniature and standard capacitors for electrical and electronic applications are being shown. Metalized film, metalized paper and film, and special printed circuit capacitors are included in the display.
9WW 405 for further details

IMHOF
A selection from their extensive range of instruments and equipment racks, cases, consoles and accessories are on display.
9WW 406 for further details

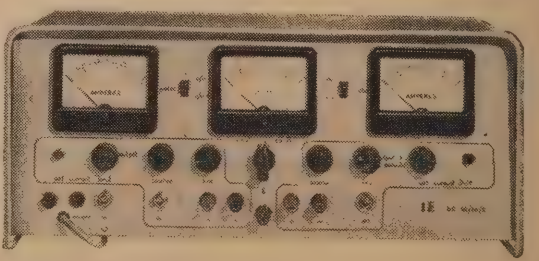
INSTRON
Instruments manufactured in the United States for testing materials

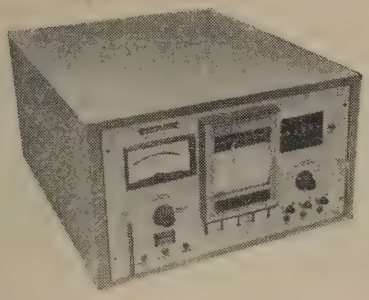


▲ *20c/s to 2Mc/s a.c. clip-on milliammeter, which measures current from 1mA to 10A, can be seen on the Hatfield Instruments stand.*

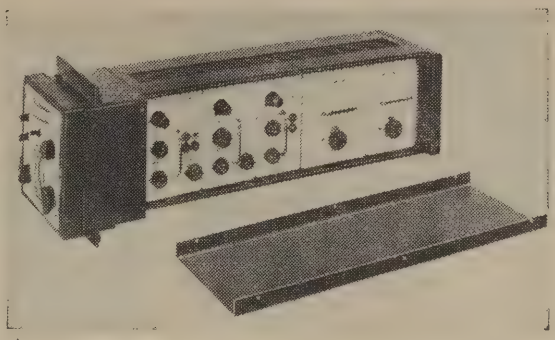
▲ *One of several dry-reed relays (Type XS4) shown by Hivac.*

▼ *Bench power unit having two outputs of 0-50V at 2A (International Electronics).*

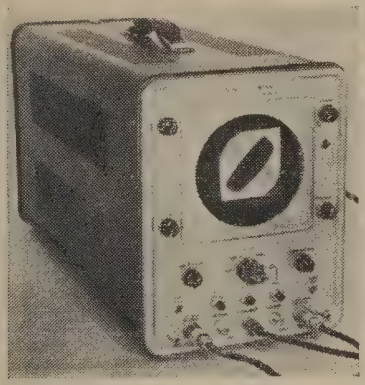




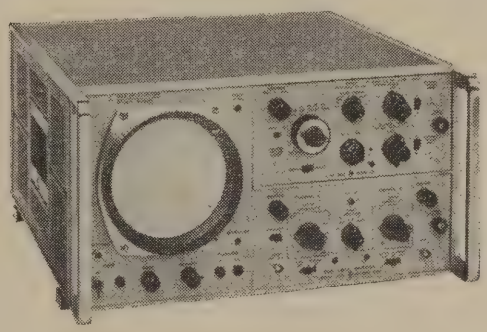
▲ *Mass flow computer introduced by Honeywell Controls.*



▲ *Proportional, integral and derivative control in process control loops is provided by this instrument of Lancashire Dynamo.*



▲ *Hughes 203 Tono-corder for the display of graphical data on a 5in storage tube.*



▲ *Hewlett-Packard 140A oscilloscope with 5in c.r. tube and X & Y plug-in units.*

are being shown. These include tensile testing machines, an optical extensometer and an environmental chamber.

9WW 407 for further details

INTERNATIONAL ELECTRONICS

Three bench power units, using the switch inductor method of stabilization, are introduced at the show, together with a digital voltmeter with four ranges giving four-digit readings up to 1, 10, 100, and 1,000 V.

9WW 408 for further details

IRELAND INDUSTRIAL DEV.

Information on the facilities offered to companies manufacturing in Ireland is provided by the Industrial Development Authority.

9WW 409 for further details

JENNINGS RADIO

This American company is featuring vacuum capacitors, vacuum power switches, and transfer and coaxial relays in vacua.

9WW 410 for further details

JOHNSON, MATTHEY

Several new developments are shown, of these the range of base- and noble-metal potentiometer wires are given prominence, as are the "Silver Star" capacitors and silver anodes. Other products on show include thermocouples, high-purity metal alloys and permanent-magnet material.

9WW 411 for further details

JOSEPH ELECTRONICS

The stand is divided into 4 sections, each part being allocated to the products of the companies represented by Joseph Electronics. The firms are Censor (Liechtenstein), Dürrwächter-Doduco-K.G. (W. Germany), Electrovac (Austria) and Witte and Sutor (W. Germany). The products on show range from components to measuring instruments and production machines.

9WW 412 for further details

KAPPA ELECTRONICS

Moisture meters, cold-cathode industrial control equipment, solid-state control devices, pressure switches and an oven are demonstrated. The oven utilizes a low-voltage magnetron producing 1 kW of microwave energy and the equipment is characterized by a simple push-button control system.

9WW 413 for further details

KERRY'S

Ultrasonic cleaning equipment, ranging from small bench units to multiple-tank cleaners, is being shown by Kerry's (Ultrasonics) Ltd. Other exhibits include ultrasonic drills, ultrasonic dip-tinning equipment and capacitor discharge stud welding equipment.

9WW 414 for further details

KEYSWITCH RELAYS

A complete range of Keyswitch type 3000 and 600 Post Office relays, and their latest P33 transistorized models, are on display. Other products on show include their low-cost Omron series of relays and their MH series of sub-miniature relays.

9WW 415 for further details

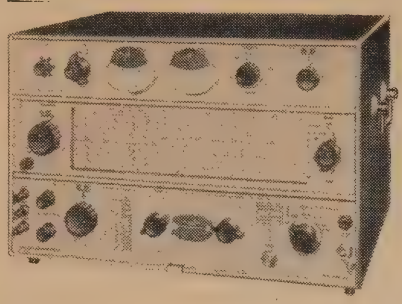
KOVO

A range of measuring instruments manufactured by TESLA and biological microscopes from Meopta Instruments are being shown on the stand of KOVO—the Foreign Trade Corporation of Czechoslovakia. A 3Mc/s millivoltmeter, precision capacitance bridge, "Q" meter suitable for operation up to 300Mc/s, a 1Mc/s universal counter, an a.m./f.m. signal generator and a stabilized power supply unit are included in the display.

9WW 416 for further details

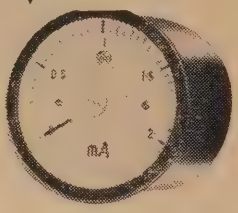
LANCASHIRE DYNAMO

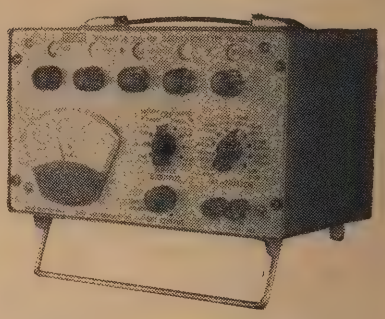
Controllers, recorders and photoelectric equipment are being shown. Among the controllers is a small



Solid-state signal generator (TF2002) covering 10kc/s to 72Mc/s in eight bands (Marconi Instruments).

Nalder long-scale (240°) pointer meter.





Levell transistor decade oscillator Type TG66A.

temperature control unit (TCT1) employing a printed-circuit transistor amplifier and a three-term controller (3TC1) providing proportional, integral and derivative control in process control loops.

9WW 417 for further details

LECTROPON

Lectropon Ltd., which was formed last year to represent American and French countries in the U.K., is showing a selection of tuning forks manufactured by Time and Frequency of Batavia, Illinois. These tuning fork oscillators are claimed to have long term accuracies ranging from 50 parts in 10^6 to 1 part in 10^7, without the use of ovens.

9WW 418 for further details

LEEDS & NORTHRUP

A feature of this year's display is the Speedomax Type W potentiometric recorder which, with a calibrated chart width of 10in, is only 15in wide and 12in high. Other equipment on display includes several portable potentiometers, a Mueller bridge, a stabilized d.c. indicating amplifier and a bench type pH indicator.

9WW 419 for further details

LEEVERS-RICH

Equipment being shown for the first time by Leevers-Rich includes a new version of their 16 mm sprocketed magnetic film recorder, a servo-controlled transcription machine for automatically copying synchronous tape recordings to magnetic film tracks, and a closed loop deck for $\frac{1}{2}$ in or 1 in tapes and speeds of from $1\frac{7}{8}$ to 60 in/sec.

9WW 420 for further details

LEVELL

The transistor decade oscillator type TG66A and the universal counter timer type TM51B are the two latest instruments in the range manufactured by Levell Electronics Ltd. Other transistor instruments on show include several r.c. oscillators and a.c. voltmeters, and an a.c. amplifier which can be used to increase the sensitivity of an oscilloscope by 10 or 100 times.

9WW 421 for further details

LEWCOS

London Electric Wire Co. & Smiths are exhibiting their comprehensive range of insulated wires and strips, some of which are self-fluxing. Other exhibits include nickel-chrome and cupro-nickel resistance wires from the Vactite Wire Company, and a selection of printed circuit boards and cable forms from Printed Circuits Ltd. The latter company is also showing printed potentiometers and resistance units.

9WW 422 for further details

LINVAR

General purpose, instrument and oscilloscope trolleys are being shown along with samples of the racks, cabinets and cases, Linvar manufacture for the electronics industry.

9WW 423 for further details

LYONS, CLAUDE

In addition to showing their own a.c. automatic voltage stabilizers and high-current stabilized d.c. power supplies Claude Lyons are exhibiting instruments by seven American, three French and one Italian firm for which they are agents. The newly formed General Radio Company (U.K.) is sharing this stand and is showing several new instruments including the 1162A decade frequency synthesizer, the 1900A wave analyser and a tone-burst generator Type 1396A.

9WW 424 for further details

LUCAS

The products of four companies in the group are shown on this stand. Bradley's are showing, in addition to their range of lasers and established instruments two new calibrators, Types 125(a.c.) and 126(d.c.), providing a stabilized voltage supply. Rotax include a range of photo-electric shaft-angle encoders with accuracies up to five seconds of arc. Additions have been made to the range of Lucas power silicon transistors, and Joseph Lucas (Batteries) are showing a new range of lightweight silver oxide/zince cells and batteries.

9WW 425 for further details

M-E-C

Miniature Electronic Components Ltd. are showing a variety of wire-wound resistors and potentiometers with a range of miniature toggle switches, whose overall diameter is less than $\frac{1}{4}$in and which project only $\frac{3}{8}$in behind a standard instrument panel.

9WW 426 for further details

M.E.L. EQUIPMENT

The M.E.L. Equipment Company, a new company formed from Mullard Equipment Ltd. and Research & Control Instruments Ltd., is showing a selection of its telecommunication equipment, closed-circuit television and ultrasonic equipment, and a selection of electronic sub-assemblies.

9WW 427 for further details

M-O VALVE CO.

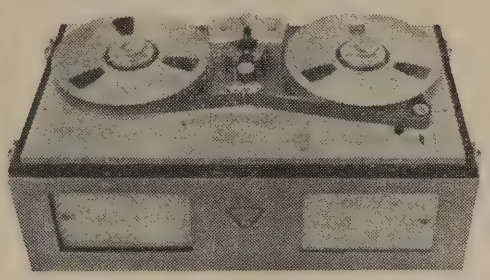
Among the many new devices being shown is a packaged semiconductor microwave generator for the 12-15 Gc/s band which has a power output of some 15 mW. Additions to the M-O range of c.r.ts is the rectangular screen 700E which has a display area of 45×24 mm and is primarily intended for the display of digital information. New valves include the E3008 directly-heated disc-seal triode. The extensive range of instruments and components displayed on this stand by Salford Electrical Instruments includes quartz crystal controlled transistor oscillators, capacitors and magnetic materials. The components group of G.E.C. (Telecommunications) is showing and demonstrating a wide range of electromechanical equipment suitable for use in data handling, remote control and electronic control systems. Of especial interest is a new relay with a volume less than 0.04 cu in and with a mechanical life expectancy of 50 million operations.

9WW 428 for further details

MAGNETIC DEVICES

A selection of relays, which the company manufactures for the electrical and electronic industries is being shown along with a selection of solenoids and sequence timers. Several coaxial and multiway connectors are also on display.

9WW 429 for further details



▲ *Leevers-Rich Series N closed-loop portable recorder.*

▲ *NSF printed-circuit edge-control rotary switch.*

MALLORY BATTERIES
Mercury, manganese alkaline and silver oxide cells are being shown in a number of different circuit applications.
9WW 430 for further details

MARCONI INSTRUMENTS
The full range of telecommunication measurement equipment is shown. However, particular prominence will be given to the "2000" range of modular instrumentation. Two new instruments are introduced at the exhibition, these are the solid-state, 10 kc/s to 72 Mc/s signal generator Type TF2002 and the transistor counter Type TF2401.
9WW 431 for further details

MARRISON & CATHERALL
A representative selection of the permanent magnets and "C" cores the company manufactures is being shown. Other exhibits include the results of a design study Marrison & Catherall has recently completed on magnets for use with reed switches and mass spectrometers.
9WW 432 for further details

MARTIN-IVO
Irion & Vosseler of West Germany, represented by Martin-Ivo, are showing for the first time in this country their comprehensive range of mechanical and electrical counters. Included in this is a complete series of totalizing and predetermining units with push-button and/or electric reset facilities.
9WW 433 for further details

McMURDO
The McMurdo Instrument Company is showing a selection of valveholders, plugs and sockets, and ancillary items. Others exhibits include a miniature electrocardiograph, logic blocks and timing devices from Louis Newmark Ltd.
9WW 434 for further details

MEASURING INSTRUMENTS (PULLIN)
A selection of miniature and hermetically sealed voltmeters and ammeters are being shown. The new "Slimline" range of panel mounting instruments is included in the display.
9WW 435 for further details

MEC-TEST
Two types of heavy-duty proximity switches, known as Proximitron Type C, are featured. The inductive type detects ferrous and non-ferrous metal at distances of up to 1½ inches and can count up to 10,000 per minute. The ultrasonic type, counting up to 200,000 per minute, is actuated by the breaking of an ultrasonic beam.
9WW 436 for further details

MICROPONENT DEVELOPMENT
Varied examples of the company's photo-etching process are being shown. By this means small quantities of complex flat metal parts can be produced cheaper than by conventional presswork.
9WW 437 for further details

MOORE, REED & CO
Various types of synchros are being shown. The display includes control transmitters, transformers and differential transmitters, torque transmitters and receivers, resolvers, and phase angle generators. A wide variety of encoders are also on display.
9WW 438 for further details

MORGANITE RESISTORS
This year's display features a precision metal-film resistor, known as the Filmet, and a high-value glass-enclosed resistor known as the Megistor. Also exhibited is a wide range of ceramic and carbon composition resistors and potentiometers together with a variety of switches for light current applications.
9WW 439 for further details

MUIRHEAD
Several new products are being exhibited at this year's show for the first time. These include a transistor wave analyser covering the frequency range 3c/s to 30kc/s, a crystal calibrator, a resistor tolerance indicator with a sensitivity of ±0.001%, and a five-decade Kelvin-Varley divider, which, while providing a constant load resistance, is accurate to ±0.01% down to a ratio of 1:100. Examples of their synchros and servo systems are also displayed.
9WW 440 for further details

MUREX
A number of instruments containing Murex sintered magnets and "Sincomax" magnets are being shown along with a new sintered magnet alloy, E.H.C., which is claimed to have the highest coercive force of all commercially available aluminium-nickel-cobalt-iron magnet alloys. They are also showing a range of tungsten, molybdenum, tantalum, niobium and zirconium products.
9WW 441 for further details

NSF
A printed circuit 10-position edge control rotary switch is introduced by NSF who are also showing their full range of "Oak" and "Cutler-Hammer" switches. Among other items of interest are Holzer timers, which are now manufactured under license by NSF, and the NSF/Union range of miniature hermetically sealed relays.
9WW 442 for further details

NALDER & THOMPSON
Long-scale pointer meters in small sizes (2½ × 4 in) are shown. These have low-inertia movements for use under conditions of vibration and shock.
9WW 443 for further details

NUCLEAR ENTERPRISES
This U.K. associate company of the Canadian organization of the same name is showing nucleonic instruments and radiation detectors.
9WW 444 for further details

OLIVER PELL CONTROL
Beside the standard range of a.c. and d.c. solenoids, motors and coils, the new, improved Varley range of miniature, plug-in relays is shown. New features of this last component include glass-filled, nylon bobbins, all-silver contacts gold-flashed and relay covers manufactured from transparent, non-gassing polycarbonate material.
9WW 445 for further details

P & H ENGINEERING
Samples of the standard instrument cubicles, cases, cabinets and consoles manufactured by this firm are being shown.
9WW 446 for further details

P.S.B. INSTRUMENTS
A strain and stress measuring bridge and a number of slow-run actuators are the latest products to join the P.S.B. range of educational and industrial instruments being shown this year. A wide range of gears and gear boxes for use with small synchronous motors for timers, chart drives, etc., are also on display.
9WW 447 for further details

PACKARD
Packard Instrument Ltd. is showing a selection of spectrometers and scintillation detectors. Other exhibits include spectrometer systems for medical, chemical, and industrial research applications, and a number of systems for gas chromatography.
9WW 448 for further details

PAINTON
Production models of a new wire-wound trimmer potentiometer are being shown. This is a version of the Painton Flatpot series and is only $\frac{5}{16}$in sq and $\frac{3}{4}$in long. It is available with standard ohmic values from 10Ω to 10kΩ. Gold flashed terminals designed to be used as printed circuit pins or as solder spills are also being shown.
9WW 449 for further details

PALMER, G. A. STANLEY
The exhibits include rechargeable batteries, high-stability, carbon-film, metal-film and wire-wound resistors, capacitors, switches and hardware such as valve holders, knobs, plugs and sockets.
9WW 450 for further details

PARAMATIC
A digital follower, for continuous monitoring of machine tools, is being shown by the machine tool control manufacturers Paramatic Engineering Ltd. Other exhibits include an electro-mechanical braking device suitable for high-speed operation and an electro-mechanical measuring unit with an accuracy of 0.0005 in over a 6 in range.
9WW 451 for further details

PERKIN-ELMER
A comprehensive range of instruments covering the fields of spectroscopy from the ultraviolet to the infrared can be examined. Also, equipment with applications in the fields of atomic absorption, gas chromatography and nuclear magnetic resonance is shown.
9WW 452 for further details

PHOTOELECTRONICS
Photoelectric and electronic aids to automation are featured in this year's show. This includes a 6-amp solid-state switch for controlling solenoids at high speed, a photoelectric infra-red burglar alarm and long-life indicator lamps.
9WW 453 for further details

PLANNAIR
The Plannette range of axial flow blowers is being shown at this year's show. Two new models, one with a 10 in diameter and the other with a 12 in diameter, have been added to their range.
9WW 454 for further details

PLATON
Flowmeters in a variety of types and sizes are shown together with accessories, including a photo-transistor alarm device.
9WW 455 for further details

PLESSEY
The Plessey Company is showing a wide range of components this year. New components include a range of sub-miniature micro switches, miniature 3-pole two-way slider switches, illuminated push-button switches, high-stability tantalum electrolytic capacitors and two new types of potentiometers. Other exhibits include 50 c/s and 400 c/s servo units from Ketay, electro-luminescence devices and photo-resistors from Ericsson Telephones, and a selection of products from Semiconductors Ltd.
9WW 456 for further details

POTTER
Three magnetic tape machines and a new "Quick-Lock" hub, which is claimed to cut the loading time on computer tape systems by an average of 80%, are among the American manufactured equipment being shown by the Potter Instrument Co.
9WW 457 for further details

PYE
Six companies in the Pye group are sharing the stand on which will be found laboratory instruments, including the new pH meter (Model 79) made by W. G. Pye, the range of transistors and "packaged circuits" produced by Newmarket Transistors and crystals and crystal ovens of Cathodeon. Medical equipment, including a cardiac pacemaker and a speech aid for the rehabilitation of laryngectomy patients, is shown by Pye Laboratories. Vibration test equipment (Pye-Ling) and a wide range of switches and control equipment by Pye Switches are also shown.
9WW 458 for further details

R.C.A. GREAT BRITAIN
Of particular interest among the semiconductors on show is the TA2307 silicon transistor which has an output of over 3 W at 400 Mc/s. Also on show are vision tape recorders, a television film projector and distance measuring equipment.
9WW 459 for further details

RAACO
A comprehensive selection from the large range of Danish-manufactured industrial storage cabinets is on display.
9WW 460 for further details

RACAL
Several examples of Racal communication equipment are being shown, including their latest transistor h.f. receiver, the RA. 217. Among the instruments featured are the type SA.535 transistor universal counter/timer, four digital frequency meters —two of which are portable instruments—and two frequency standards.
9WW 461 for further details

RANK CINTEL
The 18920/1 transistor power pack introduced by Rank Cintel is designed to deliver 6 to 30 volts at up to 500 mA. A 9 in Matricon alpha-numerical display tube is among several new c.r.ts and photoelectric cells. Latest in the family of Systron counter timers is Model 1014, an h.f. counter.
9WW 462 for further details

RECORD
The Record Electrical Company are exhibiting a number of electrical measuring instruments, the latest of which is a 4 in graphic recorder.
9WW 463 for further details

RELIANCE CONTROLS
Reliance Controls Ltd. are showing their wide range of fixed and continuously variable potentiometers. Both wire-wound and helical types are included.
9WW 464 for further details

RELIANCE GEAR
Apart from gears, the exhibits and demonstrations include magnetic clutches, bevel mitre boxes, speed reducers and limit stops. One of the demonstrations consists of a new heavy-duty, shaft angle encoder having 1,000 counts per revolution and capable of operating at 300,000 counts per minute.
9WW 465 for further details

ROBAND
A range of four oscilloscopes, each based on the Roband "5" series of interchangeable plug-in units, is introduced. Also shown is a range of data handling equipment, including digital voltmeters and remote read-out units, and a selection of stabilized power supplies.
9WW 466 for further details

ROSS, COURTNEY
Insulated and non-insulated "Sta-Kon" terminals are being shown with associated hand and power installing tools. Other exhibits include "Kent" strip terminals and automatic machines, "Ty-Rap" nylon cable straps and ties together with installing tools, and "Oddie" fasteners.
9WW 467 for further details

ROYAL WORCESTER
Royal Worcester Industrial Ceramics Ltd. are showing their full range of ceramic/metal terminals, bushings and stand-off insulators, and wafer-thin substrates. They are also showing examples of components manufactured to customers' requirements.
9WW 468 for further details

ROYCE ELECTRONIC FURNACES
The main exhibit consists of a furnace used for diffusion processes (transistor manufacture). S.c.r. temperature-control units are utilized and a uniformity of $\pm 1°C$ is guaranteed in the high-temperature zones.
9WW 469 for further details

S.E. LABORATORIES
The full range of equipment manufactured by S.E. Laboratories and its subsidiary company Meter-Flow is being shown. This includes galvanometer recorders, transducers, demodulators, strain-gauge amplifiers, oscillators and flowmeters.
9WW 470 for further details

SGS-FAIRCHILD
More than half of this stand is devoted to integrated silicon microcircuits. There will be found additions to the family of epitaxial micrologic circuits and a flip-flop, designated the μL916, which is a complete storage element in a single chip of silicon. Also being shown is a family of seven milliwatt micrologic circuits with a power dissipation of 2 mW/node. Several new

transistors, including the 2N3014 and 2N3137 n-p-n silicon planar types, are to be seen.

9WW 471 for further details

S.T.C.

In the field of micro-electronics S.T.C. is featuring the "Ministac" system of modular circuit construction and showing examples of integrated and thin-film circuits. Among the semiconductor devices shown is an epitaxial planar switch, a new 5-amp silicon avalanche rectifier and "Silring" silicon rectifier stacks. New valves include the LS950 travelling wave amplifier and an L-band klystron. Magnetic materials and a wide variety of components are also included.

9WW 472 for further details

SALTER, GEO.

George Salter & Co. Ltd. are exhibiting a selection of circlips, fasteners and springs they have produced for the instrument and electronic industries.

9WW 473 for further details

SANDERS

A representative selection of equipment from W. H. Sanders (Electronics) Ltd. is being shown. This ranges from precision gears and gear boxes to microwave and industrial control equipment. A number of kits the company produces for educational purposes are also featured.

9WW 474 for further details

SANGAMO WESTON

A selection of instruments, ranging from laboratory standards to miniature panel instruments, are being shown. Another exhibit is the Sangamo magnetic tape instrumentation system.

9WW 475 for further details

SASCO

Products of four American manufacturers—Yellow Springs Instruments, Self Organizing Systems, Kings Electronic Co. and American Super-Temperature Wires—are shown, together with information on the products of nearly 30 other companies for which SASCO are agents.

9WW 476 for further details

SCAMA

Examples of Scama annunciators, including remote relay annunciator components and accessories are on display. The Series 700 solid-state annunciator is being shown for the first time.

9WW 477 for further details

SCOTT

A new data logging system is introduced by James Scott (Electronic Engineering) of Glasgow, who are also showing a travelling wave tube power supply unit, an e.h.t. power unit and an aerial radiation pattern recorder.

9WW 478 for further details

SERVICE ELECTRONIC CO.

Various types of industrial fans, blowers and electric syrens are being displayed. Included in the display is a flat axial-flow fan with a flange-to-flange measurement of only $1\frac{5}{8}$in and a free air displacement capacity of 95 cu ft-min.

9WW 479 for further details

SERVO CONSULTANTS

The waveform generator Type 130 and the electro-hydraulic vibration table Type 175 are among the pieces of equipment featured this year. The generator produces cyclic voltage waveforms of any shape by means of pattern discs.

9WW 480 for further details

SLEE

The South London Electrical Equipment Company are exhibiting their micro welding machine, which will weld wires and tapes, down to 6 microns thickness, to metallized laminated surfaces, to micro circuits on glass substrates and to semiconductor surfaces.

9WW 481 for further details

SMITHS

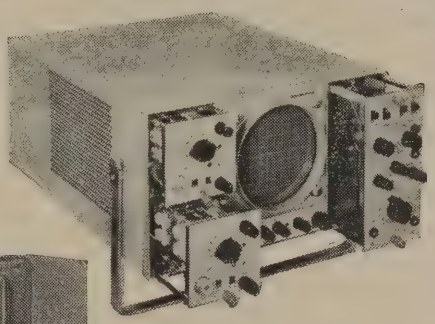
Five divisions of the Smiths organization are participating although most of the equipment shown and all the new items are from the Industrial Division. The equipment on show for the first time in the U.K. includes an electronic tachometer, solid-state temperature controllers, new pen recorders with transistor amplifiers and attenuators, two slidewire potentiometric recorders and Motorola telemetry equipment.

9WW 482 for further details

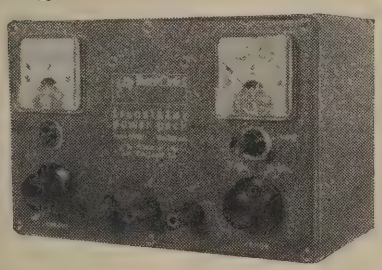
SOLARTRON

Several new Solartron instruments are being shown for the first time. Among these is a 5-in double-beam oscilloscope with plug-in X and Y amplifiers and an integrating digital

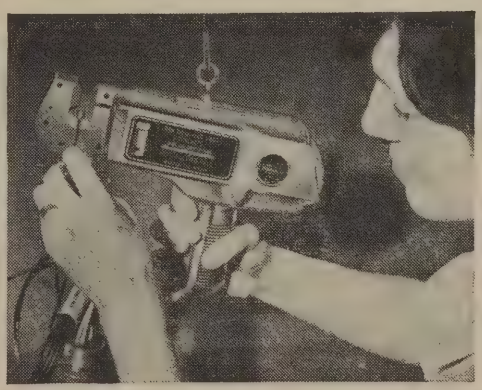
Solartron CD140 with 5in double-gun c.r.t. and plug-in X and Y units. ▶



Transistor power pack (18920/1) to deliver 6-30V at up to 500mA (Rank Cintel). ▼



This portable power-crimping tool is being shown by the Plessey Company. ▶



One of the series of Roband oscilloscopes (RO50). ▶

voltmeter. A selection of their current instruments is also being shown. In addition to their own equipment, products from overseas companies—who they are connected with—are being displayed. An a.c./d.c. digital voltmeter from Rochar Electronique is included in this section.

9WW 483 for further details

SPERRY

More than a hundred electrical servo components are on show along with several systems Sperry have introduced for industrial control applications. Among the working demonstrations is one showing Sperry's data transmission and logging equipment. Another shows a new solid-state digital system capable of handling from six to many thousands of parameters.

9WW 484 for further details

STEATITE

A selection of the miniature and subminiature ceramic components manufactured by Steatite Insulations Ltd. is being shown. A wide range of ceramic capacitors is also being exhibited.

9WW 485 for further details

STRATTON

Several Eddystone receivers are on show this year together with a range of panoramic display units. These units, which are suitable for use with the Eddystone range of receivers and some others, provide a visual display of any received signal and are intended for both operational and laboratory applications.

9WW 486 for further details

T.C.C.

New ranges of plain and etched tantalum foil tubular capacitors, plug-in plastic-case electrolytics for printed circuits, monolithic ceramic capacitors, "Hikonol" energy storage capacitors for laser applications and subminiature electrolytics for potted assemblies are among the components selected for exhibition. A display of T.C.C.-Sprague components is also included.

9WW 487 for further details

T.M.C.

In addition to showing a selection of their own capacitors, the Telephone Manufacturing Company is showing capacitors produced by Pirelli Applicazioni Elettroniche of Italy and the General Instrument Corporation of the U.S.A. Other exhibits include a variety of push-button and lever keys, Carpenter polarized relays, read-out counters and solid-state circuit elements. Data transmission equipment is also being shown.

9WW 488 for further details

TANNOY

Examples from the wide range of equipment available for public address, sound reinforcement, and audio systems for particular circumstances—flameproof, inductive loop, etc.—are on show. Tannoy are also showing transducers for environmental vibration testing.

9WW 489 for further details

TAYLOR INSTRUMENT

Taylor Instrument Companies (Europe) Ltd., formerly Taylor Controls Ltd., are showing a selection of the electronic and pneumatic instruments they manufacture for the process industries.

9WW 490 for further details

TECHMATION

As agents for the Infotronics Corp., of America, this company is showing their new automatic electronic digital integrators. They are also showing equipment manufactured by Micro-Tek Instruments of the U.S.A.

9WW 491 for further details

TECHNA (SALES)

A range of E-T-A miniature circuit breakers for single and three phase use with ratings from 50 mA to 30 A are featured.

9WW 492 for further details

TECHNOGRAPH

Technograph & Telegraph Ltd.—a new company resulting from the merging of the printed circuit division of the Telegraph Condenser Company with Technograph Electronic Products Ltd.—are showing circuits made by a new process which, they claim, are cheaper to make than those using standard etched foil techniques. A complete range of etched foil processed circuits are also exhibited.

9WW 493 for further details

TEDDINGTON

Teddington Aircraft Controls Ltd. are exhibiting a representative selection of their precision logging and monitoring instruments. These consist of potentiometric pressure transducers and miniature potentiometers.

9WW 494 for further details

TEKTRONIX

The type 647, d.c. to 50 Mc/s, oscilloscope is one of the latest instruments to be added to the Tektronix range of oscilloscopes. A selection from their current range of instruments, many of which are of modular construction, is being shown along with their auxiliary instruments and accessories. The sensitivity of the type 647 is 10 mV per cm.

9WW 495 for further details

TELCON METALS

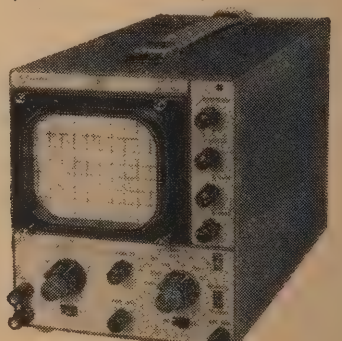
Glass sealing alloys with a super-fine finish and a wide range of thermostatic bimetals are included in this year's display. Other exhibits include a range of transformer, transductor and choke laminations from Magnetic and Electrical Alloys Ltd., a range of "C" type cores from Telcon-

(*Continued on page* 293)

▲ *Some of the industrial cathode ray tubes being shown by Thorn-A.E.I. Radio Valves & Tubes Ltd.*

Telequipment Type S51A oscilloscope with calibrated sweep speeds from 100mséc to 1μsec per cm.

▼



Marconi self-tuning H.F system—the first in the world to be station planned from input to output.

MST

breakthrough

MST 30kW transmitter type H1200

An h.f linear amplifier transmitter for high-grade telecommunications.
Frequency range: 4-27.5 Mc/s.
Output power: 30 kW p.e.p, 20 kW c.w.
Meets all CCIR Recommendations.

saves 80% floor space

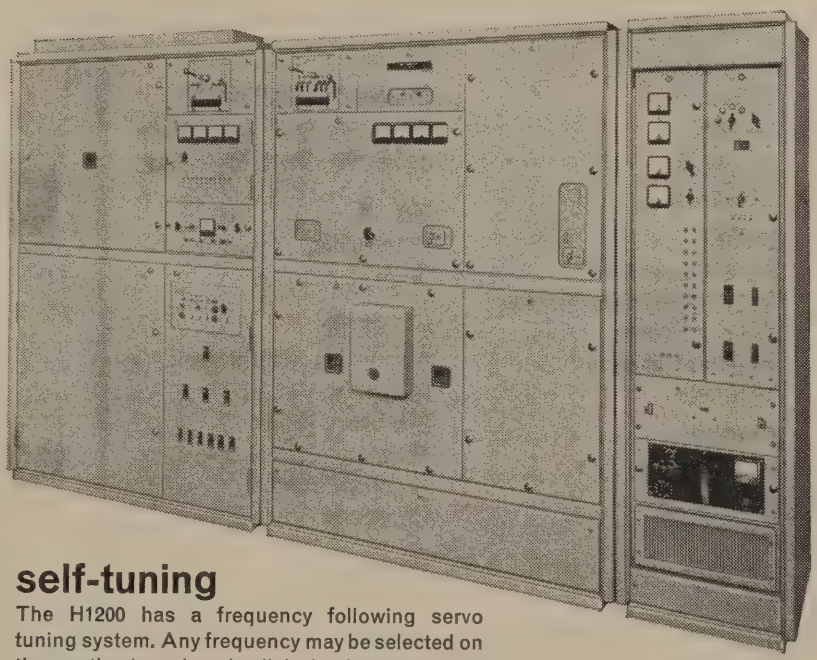
Transmitters can be mounted side by side and back to back or against a wall. Floor-ducts are eliminated and all power supply components are built-in. These features lead to smaller, simpler, cheaper buildings or more services in existing buildings.

rugged reliability

R.F circuits have been simplified and the number of mechanical parts reduced to a minimum. Highest engineering standards are applied to the design of these parts: stainless steel shafts in ball-bearings in heavy, rigid, machined castings; stainless steel spur gears meshing with silicon bronze; heavy r.f coil contacts with high contact pressure. Specified performance is maintained with ample margins.

simplicity

MST reliability allows continuous unattended operation with extended or remote control, saving maintenance and operating staff. Any fault in the servo control circuits can quickly be located with simple test routines. Transistors and printed wiring give these circuits maximum reliability.



self-tuning

The H1200 has a frequency following servo tuning system. Any frequency may be selected on the synthesizer decade dials in the associated MST drive equipment; the unattended transmitter automatically tunes itself in an average time of twenty seconds. Final stage tuning and loading servos continuously ensure automatic compensation for changes in aerial feeder impedance caused by weather conditions. Self-tuning gives *one-man* control of an entire transmitting station.

Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England

LTD/H51

9WW—104 FOR FURTHER DETAILS.

PLUGS & SOCKETS
IMMENSE RANGE—IMMEDIATE DELIVERY

AMPHENOL
Co-axials
Microphone
MS Range
MS Type Hermetic Seal
MS Type MinniE
Printed Circuit
SERIES 26, 57, 67, 69, 75, 77, 78, 80, 86, 91, 97, 126, 133, 143, 165, 172.

BELLING & LEE
Co-axials
Screenectors
Unitors

CANNON
MS Range

ELCO
Edge Connectors
Micro-Miniature Varicon
Printed Circuit
Rack and Panel
Varicon

ETHER
Miniature
Printed Circuit
Sub-Miniature

KINGS
Co-axials
UG Range (including Captive Contacts)
SERIES BN, BNC, C, HN, LC, LT, PULSE I.N, N, UHF, TWIN, KG, TNC, KP, SM, KM, TPS.

MCMURDO
DEE Range
Octal Plugs and Sockets
Printed Circuit Edge
Red Range
Standard Range
Strip Connectors

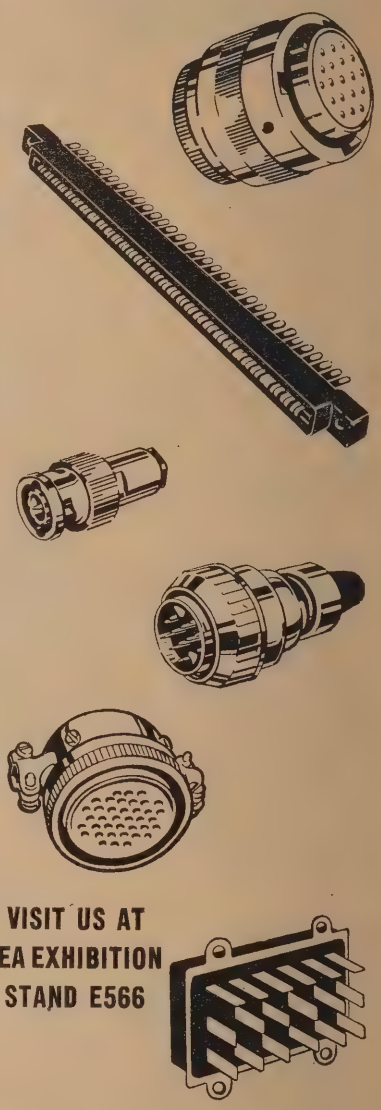
MAGNETIC DEVICES
Miniature Sealed Co-axials
Multi-way Back Mounting

MK. IV
Aluminium
Brass

PAINTON
Heavy Duty Multicon
Microcon
Miniature Jones
Multicon
Printed Circuit
159 Series

THORN
MS Range
Miniature Bayonet Lock Range

Additional British Types under A.M. sections 5A, 5B, 5C, 5D, 5X, 10H, 105G, 105X, 110H. Joint Service 'Z' No's. Army ZA No's. Admiralty AP No's. Nato Part No's and P.O. Types.



VISIT US AT IEA EXHIBITION STAND E566

A products list covering the complete range of Electronic Components stocked by SASCO available on request.

SASCO

STEWART AERONAUTICAL SUPPLY CO. LTD.

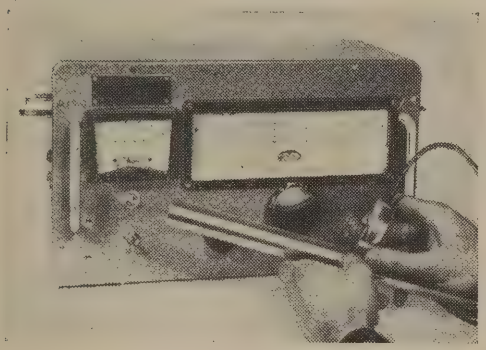
P.O. Box 20, Gatwick Road, Crawley, Sussex.
Tel: Crawley 28700
Telex No: 87131. Cables: SASCO, Crawley, Telex

9WW—105 FOR FURTHER DETAILS.

Single gun electrical storage tube from 20th Century Electronics. ◀

A high vacuum machine from the Vacuum Electronics Corp., of New York. It can be seen on the British subsidiary's stand Veeco Instruments Ltd. ▶

A film thickness meter from the Ultrasonoscope Company. ▼



Magnetic Cores Ltd. and a selection of resistance wires from Temco Ltd.
9WW 496 for further details

TELEDICTOR
A selection of s.c.r. power supply units, with outputs of up to 100 amps at 250 volts, are being shown. A series of electronic timers and a number of transformers are included among the other exhibits.
9WW 497 for further details

TELEQUIPMENT
The full range of oscilloscopes is both shown and demonstrated. The new instruments include the Type S51A, which has a 5in, flat-face tube and calibrated sweep speeds from 100msec/cm to 1μsec/cm and the Type S51E which is an oscilloscope specifically designed for educational use.
9WW 498 for further details

THERMAL SYNDICATE
Examples of pure fused quartz and silica, and of high temperature refractories, are being shown. These include "Spectrosil," a high-purity silica, with high transmittance in the ultraviolet region.
9WW 499 for further details

THORN
The Thornvision closed-circuit television equipment forms the major part of a display of control equipment from Thorn Electronics Ltd. Thorn's special products division is showing a wide range of exhibits in the components field, including electroluminescent lamps.
9WW 500 for further details

THORN-A.E.I.
Thorn-A.E.I. Radio Valves and Tubes Ltd. are exhibiting a wide range of valves and cathode ray tubes under their brand names Brimar, Mazda and Ediswan (export). The recently formed industrial cathode ray tube division is showing several new tubes, including a camera viewfinder tube of extremely compact dimensions and two p.p.i. tubes for transistor radar applications.
9WW 501 for further details

TINSLEY
Precision components and laboratory measuring instruments are being shown. An interesting exhibit is a six-figure low resistance potentiometer, known as the Stabaumatic Type 5545, reading from zero volts to 1.51110 V.
9WW 502 for further details

TOPPER CASES
A variety of cases, including some for scientific instruments and radio equipment, in leather, plastics, covered board, etc., is shown.
9WW 503 for further details

TRANSITRON
A new version of the Transwitch—an s.c.r. device which can be turned "off" at the gate—with a current rating of 5 amps and a bilateral switching diode, which will replace two s.c.rs in certain full-wave phase controlled applications, are featured this year. Other exhibits include many examples of their semiconductors, integrated circuits and special encapsulations.
9WW 504 for further details

TRUMETER
A selection of electrical and mechanical counters is being shown. The "Excelsior" digital control "brick" is included in the display.
9WW 505 for further details

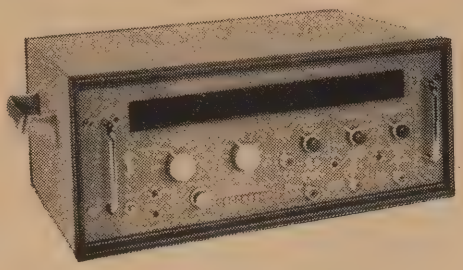
TURTON BROS. & MATTHEWS
A comprehensive selection of permanent magnets is being displayed. Magnets with brazed polepieces, for various instrument applications, and magnets for use in reed relays are among those in the display.
9WW 506 for further details

20TH CENTURY
Cathode ray tubes, storage tubes and photomultipliers are on show this year. A fully automatic mass spectrometer leak detection equipment, for individually leak-testing small sealed components, is among the other exhibits on display.
9WW 507 for further details

ULTRA
The four divisions of the company—Control and Instrumentation, Automated Business Systems, Special Products, and Telecommunications—are all participating on this stand. The display includes industrial control systems, ultrasonic equipment (including the recently introduced aid for the blind), communication sets and audio equipment.
9WW 508 for further details

ULTRASONOSCOPE
Ultrasonic testing instruments with a varied selection of probes are being shown this year. The Ultrasonoscope dual-channel alarm units and surface film thickness meters are included among the other exhibits.
9WW 509 for further details

UNION CARBIDE
Solid tantalum capacitors, barium getters, semiconductor silicon, silicon monoxide and a range of industrial crystal products including synthetic gems for masers and lasers are shown.
9WW 510 for further details



▲ *Venner TSA3338 time/frequency measuring instrument.*

Carpenter-type relay test set (Whiteley). ▶

VACTRIC
A.C. and d.c. servo motors, a.c. tachogenerators, servo gearheads, rotary sampling switches and breadboard components are included in this year's display. A range of Ugon subminiature relays is being shown, and also the new Vacsyn slow-speed (60 r.p.m. at 50 c/s) synchronous motor.
9WW 511 for further details

VEECO INSTRUMENTS
Two ionization gauge control instruments, the RGLL-6 and the RGS-6, and a high vacuum machine are being shown. These products are manufactured by the parent company, the Vacuum-Electronics Corporation of New York.
9WW 512 for further details

VEEDER-ROOT
Electronic, electrical and mechanical counters including one remotely driven by a stepping motor and programmed by a solid-state circuit, are being displayed.
9WW 513 for further details

VENNER ELECTRONICS
A pre-production model of the TSA 3338 time/frequency measuring instrument is on show. It has an 8-digit in-line projection display and can be used to measure direct frequency up to 50 Mc/s and time in units of 0.1μsec. Among other instruments, for industry and research, being shown this year is the Type TSA 648 variable rise time pulse generator. Another is the TSA 65 transistorized digital printer.
9WW 514 for further details

WANDLESIDE
Equipment wires with and without screening are being shown. Other exhibits include p.t.f.e. multicore instrumentation cables, flame-resistant cables for continuous operation at 260°C, or at 1,100°C for five minutes, and a selection of r.f. coaxial cables.
9WW 515 for further details

WAYCOM
The Wima range of polyester, paper and low-voltage electrolytic capacitors made by Wilhelm Westermann, of West Germany; Piher carbon film resistors from Spain; Fujisoku subminiature switches from Japan; and S.E.C.M.E. switches and connectors made in France are being displayed.
9WW 516 for further details

WAYNE KERR
A number of new bridges, including the "Autobalance" and the recently introduced "Midge" types are on display. Also on show is a comprehensive display of instrumentation for the accurate measurement of displacement and vibration, the generation of audio, video and pulse signals, and the analysis and equalization of control systems. The "Digitec" series of voltmeters is also featured.
9WW 517 for further details

WELMEC
The Welmec Corporation Ltd. is showing a selection of products of the West German companies which it represents. These include: xenon, mercury and spectral lamps from Osram G.m.b.H.; and electrical components, portable electric tools and a sheet metal shear machine—with a cutting capacity in mild steel of 14 gauge—from A.E.G.
9WW 518 for further details

WELWYN ELECTRIC
Two new ranges of insulated metal film resistors and a new range of vitreous enamelled wire-wound resistors have been added to Welwyn's comprehensive display of resistors. Examples of their film networks and micro-electronic assemblies are also being shown.
9WW 519 for further details

WESTOOL
Electric and electronic control equipment and components are featured at this year's show. This includes a wide variety of a.c. and d.c. solenoids, chokes and transformers. The Sonac range of ultrasonic sensing and switching equipment is also being shown.
9WW 520 for further details

WHITELEY
Instruments on show include a variety of Post Office test sets, cable location equipment, variable r.f. attenuators, variable decade boxes and a test set for checking Carpenter relays. Encapsulated audio amplifiers, oscillators and transformers, the Whiteley range of loudspeakers and amplifiers and the radio sonde are also exhibited.
9WW 521 for further details

WIRE PRODUCTS
As suppliers of "components of components" Wire Products & Machine Design are displaying an extensive range of pins, wires, rivets, printed circuit connectors and glass-to-metal seals.
9WW 522 for further details

WODEN
The Woden Transformer Company is displaying a comprehensive range of torque motors, transformers and chokes, and a wide variety of patchboards, card readers and wire contact relays.
9WW 523 for further details

WOOD, HUGH, & SON
A selection of transistor test equipment, for measuring d.c. parameters of n-p-n and p-n-p devices on a "go"-"no-go" basis, is included in the variety of Baird-Atomic products being shown. This includes a full range of nuclear equipment for medical, biological and industrial applications.
9WW 524 for further details

ZEAL
Among the many types of thermometers made by these specialists are included miniature sensing elements based on thermistors.
9WW 525 for further details

LETTERS TO THE EDITOR

The Editor does not necessarily endorse opinions expressed by his correspondents

Thévenin and Norton

WITH reference to Fig. 4 in " Cathode Ray's " interesting paper on the Thévenin and Norton theorems (January 1964 issue), the very correct statement is made that $r_a i_a^2$ differs from the anode dissipation $\tilde{P}_a$ (the internal power loss) when the tube is in operation. This does not, however, rule out the calculation of $\tilde{P}_a$ with the aid of the equivalent a.c. generator, provided that the plate dissipation P_a without signal is known to us, and provided that we do not fail to acknowledge that there must exist an input signal power $\mu v_g i_a$ to the equivalent generator, which power can only come from P_a. Thus the impossible relation and the true relation become

$$\tilde{P}_a = r_a i_a^2 \text{ (false)}, \quad \tilde{P}_a = r_a i_a^2 - \mu v_g i_a + P_a \text{ (true)}.$$

The author derived this formula in 1944.[1]

" Cathode Ray " brings out some interesting aspects of Thévenin's and Norton's theorems, and I should like to take the opportunity to bring out some of the thoughts prevailing on this side of the Atlantic, and also to bring out some of the limitations of the theorems in the calculations of tube and transistor networks.[2] Although Thévenin's theorem originally was stated for d.c., we boldly go ahead today and use it in the periodic steady state, with sinor variables, and in transient calculations, with phasor variables. Further, Thévenin's sources were independent, but a large number of the sources we encounter today in tube and transistor networks are dependent. The theorem formulation gives us no clue to the treatment of any kind of dependent sources. Accordingly, errors often result when students attempt to apply this theorem and the related Norton theorem. One rather common error is that students occasionally list r_a of a tube amplifier as the output resistance. When the source μv_g is dependent, meaning that it is a function of a current or voltage somewhere else in the system, r_a is not the output resistance. Following the classical theorem formulation, we would " passivate " the network by eliminating all sources to obtain the series resistance in the equivalent, but with dependent sources present we cannot do this and then enter the open circuit output voltage in series to complete the equivalent generator. (The equivalent only becomes correct if we enter a modified form of the open circuit voltage.) Many students are at a loss when trying to apply the theorems to rather common tube and transistor networks, and clearly a " modified " theorem is badly needed; one that is valid under all conditions. The author has formulated such a theorem, intended to replace the Thévenin and Norton theorems in the analysis of tube and transistor networks, but before we discuss this new theorem, let us take a look at a simple application example.

The network in Fig. 1(a) may represent a part of a tube or transistor amplifier network, and is symbolic for the way in which a dependent source enters in, although the dependent source may not appear precisely in this fashion. Except for the dependent current source kI_1, the network is in principle the same as that shown by " Cathode Ray " in his Fig. 2(a). Apparently, we cannot open the function source in a formal application of Thévenin's theorem to obtain the equivalent in Fig. 1(b). We can open the source kI_1 and obtain R as equivalent generator resistance, but the voltage source required in series then differs from that prescribed by the Thévenin theorem. The student ultimately finds ways to determine the equivalent network in Fig. 1(b), but he is not securing the result by a direct application of the Thévenin theorem. As an example, he may write $E^\star = V_{open}$, and then make use of the Applied Source Method to determine $R^\star$ (applying a measurement voltage to the terminals in Fig. 1(a) with $E_1 = 0$). As another alternative, he may determine the short-circuit current and then apply Ohm's law, thus obtaining $R^\star = V_{open}/I_{short}$. But this is a more elaborate procedure then to have available a theorem that gives $R^\star$ merely upon inspection of the network.

$E^\star$ and $R^\star$ in the equivalent network in Fig. 1(b) are as follows

$$V_{open} = E^\star = \frac{(1+k)\,R_2 E_1}{R_1 + (1+k)R_2} \quad .. \quad .. \quad (1)$$

$$R_{out} = R^\star = \frac{R_1 R_2}{R_1 + (1+k)R_2} \quad .. \quad .. \quad .. \quad (2)$$

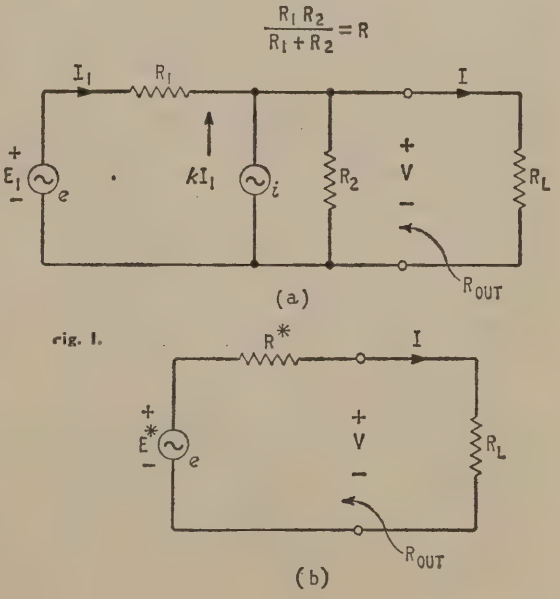


fig. 1.

[1] H. E. Stockman " The Validity of the Equivalent Plate-Circuit Theorem for Power Calculations," *Proc. I.R.E.*, Vol. 32, No. 6, June 1944.

[2] The history of Norton's contribution to " Norton's theorem " is as follows.

The first statement of the theorem pertains to a patent communication of November 3, 1926 (unpublished). It reads " It is ordinarily easier, however, to make use of a simple theorem which can readily be proved that the effect of a constant voltage E in series with an impedance Z and the network is the same as a current I = E/Z into a parallel combination of the network and the impedance Z." The first published statement of the theorem appeared in the first edition of professor W. L. Everitt's book on network theory, which must have been published in the late 1920's or early 1930's. Professor Everitt visited Bell Telephone Laboratories and talked with R. V. L. Hartley. Mr. Hartley mentioned the theorem, and gave Norton the credit for originating it. (Personal correspondence with E. L. Norton, April 24, 1963).

It is apparent from this that both the Thévenin theorem and the Norton theorem were originated for *independent sources* only. It is therefore logical that the theorems fail when applied to dependent sources, and that a new theorem is needed to handle dependent (and independent) sources.

The conventional Thévenin theorem gives (1) but not (2), so when we talk about a modification of the theorem, we are merely talking about some new way of obtaining (2). The theorem to be described provides precisely this, and it does so in an exceedingly simple and direct fashion. The theorem is equally valid for impedance and admittance; both here referred to by means of the term immittance. Further, this immittance may be a complex quantity, such as $j\omega L$ in periodic steady-state problems, or a Laplace Transform, such as sL in problems on transients. It is a foregone conclusion that the transfer function we are using truly represents the network under discussion, and as an example here R_{out} could not very well be obtained from a current ratio transfer function, leaving the input open. The new theorem has the following formulation:

A linear network with any arrangement of dependent and independent sources may with reference to a specified port be represented by an equivalent generator with an immittance equal to the denominator of vanishing load immittance in the selected transfer function, and with the open port voltage in series or the closed port current in parallel.

We note that this theorem replaces both Thévenin's and Norton's theorems. The port mentioned in the theorem is the selected or observed terminal pair. Usually, the driving generator, which may be a signal generator in the laboratory occupies the other port in the typical two-port configuration of a tube or transistor amplifier. Applying the new theorem to the network used as an example in Fig. 1(a) we probably already have the transfer function in (1) available in its complete form, which is

$$\frac{V}{E_1} = \frac{(1+k)\,R_2\,R_L}{R_1\,R_2 + [R_1+R_2\,(1+k)]\,R_L} \quad .. \quad .. \quad (3)$$

Inspecting the denominator, we produce R_L as a single term and let it vanish, following the theorem formulation. The result is $R_{out} = R^*$ as given by (2). This method is much faster than the Applied Source Method, and very often R^* is determined in the matter of seconds. Since this theorem holds for all kinds of sources, it makes the Thévenin and Norton theorems superfluous. While these theorems employ a briefer transfer function, they require inspection of the network to determine the combination resistance, but nevertheless fail to handle dependent sources. The new theorem extends the transfer function to the load, but no inspection of a known network diagram is required since the transfer function denominator gives the generator immittance, and dependent sources are handled just as easily as independent sources.

If the output immittance only is of interest, the theorem shrinks to the following form:

The output immittance is the denominator of the selected transfer function as the load immittance vanishes.[3]

This practical theorem is becoming known in the U.S.A. under the name the "Denominator Output Immittance Theorem," and the time-saving feature of this theorem shall now be demonstrated by means of three typical transistor transfer functions:

$$-\frac{I_2}{I_1} = \frac{-z_{21}}{z_{22} + Z_L} \quad \text{yields directly } Z_{out} = z_{22},$$

$$\frac{V_2}{V_1} = \frac{-h_{21}}{\Delta h + h_{11}Y_L} \quad \text{yields directly } Y_{out} = \frac{\Delta h}{h_{11}}$$

$$\frac{I_2}{I_1} = \frac{-1}{a_{12} + a_{11}Z_L} \quad \text{yields directly } Z_{out} = \frac{a_{12}}{a_{11}}$$

It is hoped that this discussion of Thévenin's and Norton's theorems may serve as a useful extension to "Cathode Ray's" timely paper and that it will illuminate the limitations of the classical theorem formulations.

Lowell, Mass., U.S.A. H. E. STOCKMAN
Lowell Technological Institute.

H. E. Stockman "Three Output Immittance Theorems," *Electronic Industries*, January, 1958.

Automatic Error Correction

THE article by Mr. P. R. Keller in the February and March issues gives a concise description of error-correcting codes and the Marconi "Autospec" system.

It seems probable that regeneration of the received signal is inherent in the "Autospec" equipment. This being so, improvement, due solely to use of the error-correcting code, is not apparent and a fairer comparison would be of a regenerated teleprinter copy and the "Autospec" copy. Perhaps Mr. Keller could provide some figures.

In Fig. 3 almost 100% of the checkable corruptions are due to extra Z elements whereas at least 90% of the checkable corruptions in Fig. 4 are due to extra A elements (assuming that an A.T. & E. coder was used for the tests shown in Fig. 4). Is this due to the controller test conditions or was a bias control overlooked?

Winchester R. A. JUBB

The author replies:

As Mr. Jubb surmises, regeneration is included in the "Autospec" equipment which has a margin of not less than ± 45% against distortion of the received signal. The margin of a teleprinter would be of the order of ± 30% to ± 42% dependent on adjustment, and may, or may not, be balanced. Some improvement might be due to this factor alone, but this is small in comparison with the improvements resulting from (a) the use of synchronous as opposed to start-stop working, and (b) the use of the error-correcting code.

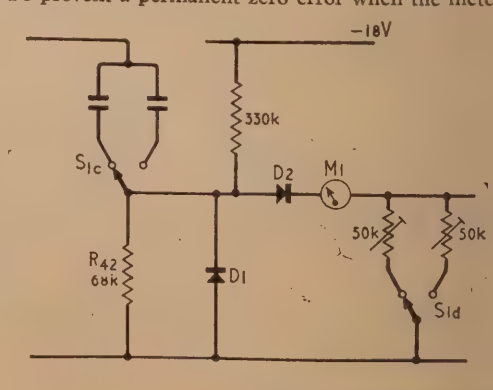
The order of improvement resulting from these causes is indicated in Table IV (p. 121, March issue), which relates to basic element error rates.

The arrangements for the tests shown in Figs. 3 and 4 were typical of practical cases, and, as Mr. Jubb points out, there was imbalance between A element errors and Z element errors (in opposite senses in the two tests). This may be due to a number of causes including bias distortion in the signal output from the radio receiver tone detector, and differential positive and negative margin in the teleprinters. However, as mentioned above, the improvement is more a function of a basic element error rate than of whether this error rate is due to bias distortion, noise, or other factors. Noise was the dominant factor in determining the error rate at the levels used in these tests, while bias distortion and margin asymmetry accounted for the errors affecting predominantly A or Z elements. P. R. KELLER

Frequency Meter

A RECENT requirement for a frequency meter prompted me to make up the frequency-measuring section of the *Wireless World* Audio Signal Generator. Using a 100 μA meter (the only one available) I found a maximum error of about 10% due to the blip where the positive pulse is clipped by the diode. This was corrected by biasing the diode with a 330 kΩ resistor to the negative supply and the resulting zero error is corrected mechanically at the meter.

To prevent a permanent zero error when the meter is



switched off, with the temptation to anyone to correct it, the 330 kΩ bias resistor is connected direct to the battery negative. This gives a permanent drain of about 50 μA which should not appreciably affect the life of the battery.

The instrument now gives good linearity over the required range of 5 c/s to 5 kc/s and a 50 μF capacitor across the meter reduces flutter at low frequencies. The modified discriminator circuit is shown in the accompanying figure.

Leigh-on-Sea. C. J. MILLS

Loudspeaker Polarity

DURING the course of recent experiments I have come across a phenomenon which, for lack of any previous reference, I propose to call the "Wooller effect." It started when I was observing oscillograms of various instruments and noted that while strings looked symmetrical, brass and woodwind were definitely unsymmetrical, being characterized mainly by a large repetitive peak in one direction only. This, I reasoned, must correspond to either a pressure or a rarefaction wave—probably the former. And so the question arose —"Would the instrument sound different if it were reproduced with loudspeaker phasing such that these peaks caused a rarefaction wave?" So, together with some very sceptical friends, who have subsequently agreed to endorse by findings, I tried a listening test. Reversing the phase of both speakers (to avoid any argument about relative phasing for stereo) we found that on brass especially there was a distinct difference in the "life" of the performance. The phasing which corresponded to the most realistic performance was not the same for all records, thus showing that the effect was not caused by non-linearity in the reproducing system, and also that there is no standardization among manufacturers concerning which direction of stylus movement corresponds to an increase of pressure at the microphone. Both mono and stereo records were tried with similar results.

Auckland, New Zealand. A. M. WOOLLER, A. THORLEY, J. T. BOYS

BOOKS RECEIVED

Mathematical Techniques in Electronics and Engineering Analysis, by J. W. Head, M.A. (Cantab), F. Inst. P., A.M.I.E.E. Based on a series of articles published in *Electronic and Radio Engineer* (now *Industrial Electronics*) this book is a self-contained guide to the use of algebra, the differential and integral calculus, trigonometry, operational calculus, matrices, etc. in the solution of engineering problems, particularly those encountered in light-current electrical engineering. Pp. 263. Iliffe Books Ltd., Dorset House, Stamford Street, London, S.E.1. Price 45s.

Propagation of Radio Waves at Frequencies below 300 kc/s, edited by W. T. Blackband. Proceedings of the 7th meeting of AGARD Ionospheric Research Committee, Munich, 1962, comprising a total of 32 papers grouped under the heading: the lower ionosphere; D-layer irregularities; the lower ionosphere and low-frequency propagation; oblique incidence measurements; radio noise below 300 kc/s; v.l.f. propagation; e.l.f. propagation; earth resonance. Pp. 478. Pergamon Press Ltd. Headington Hill Hall, Oxford. Price £7.

Transistor Circuits for Magnetic Recording, by N. M. Haynes. Deals with the fundamentals of transistor theory and (largely on a qualitative basis) with the elements of recording and playback circuits. One chapter includes the circuit diagrams (with values) of a number of commercial recorders. There are useful chapters on f.m. and digital recording. Pp. 384. Howard W. Sams & Co. Inc., Indianapolis 6, Indiana, U.S.A. Price $9.95.

Schaltungstechnik der Loewe Opta Fernsehempfänger, by Ing. F. Möhring. Thorough analysis (in German) of one firm's television receiver circuits, profusely illustrated by photographs of waveforms and corresponding picture characteristics. Gives a close insight into the performance of all stages of the television receiver and a general indication of Continental receiver practice. Pp. 442. Loewe Opta A. G., Industriestrasse, Kronach, Germany. Price DM 4.50.

Understanding Television, by J. R. Davies. Based on a series of articles in *The Radio Constructor* this book describes in detail the elements of a television receiver. Essential differences between the 405- and 625-line standards are dealt with throughout the book and there is a chapter at the end on colour (including N.T.S.C., SECAM and PAL) and an appendix on u.h.f. tuners. Pp. 504. Data Publications Ltd., 57, Maida Vale, London, W.9. Price 37s 6d.

Colour Television Explained, by W. A. Holm. Extends the author's earlier work on "How Television Works" and gives a clear and succinct description of fundamental colour theory and of the N.T.S.C. colour television system (both transmission and reception). Pp. 110. Philips Technical Library, Cleaver-Hume Press Ltd., 10-15 St. Martins Street, London, W.C.2. Price 20s.

Properties and Applications of Transistors by J. P. Vasseur, D. es S. Based on a series of lectures on transistor theory and practice to colleagues in the Compagnie Générale de Télégraphie Sans Fils (C.S.F.) this book constitutes a useful cross-reference on all matters relating to design. The two-port (four pole) network approach, necessary to differentiate between transistor and valve action, is clearly and fully presented. Pp. 434. Pergamon Press Ltd., Headington Hill Hall, Oxford. Price £5.

Diodes and Transistors, by G. Fontaine. English translation from the French of a treatise published in 1961 in the Philips Technical Library gives a clear exposition of the physics of semiconductors and the general theory of diodes and transistors. The book is non-mathematical but is liberally illustrated with line diagrams in which the use of three colours materially aids comprehension. Pp. 470. Cleaver Hume Press Ltd., 10-15 St. Martin's Street, London, W.C.2. Price 55s.

Filters, A Handbook on Theory and Practice, by the staff of White Electromagnetics Inc. A collection of design data and graphs covering low-, high- and band-pass passive filters with maximally flat (Butterworth) or equal-ripple (Tchebycheff) responses over a frequency range from 30 c/s to 500 Mc/s. A useful practical guide for designers. Pp. 279. White Electromagnetics, Inc., 670 Lopstrand Lane, Southlawn Industrial Park, Rockville, Maryland, U.S.A. Price $11.75.

Proceedings of Symposium on Extended Range V.H.F. Air/Ground Communications held at the Royal Geographical Society, May 1963 describes the equipment in aircraft and on the ground, records the results of trials and the discussion for criteria for presenting and assessing the performance of extended-range v.h.f. facilities. Pp. 162. The Engineering Division, International Aeradio Ltd., Hayes Road, Southall, Middlesex. Price £2.

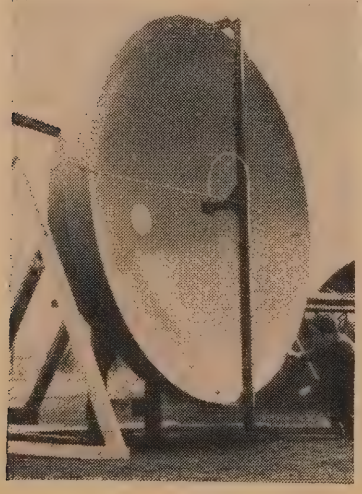
RECENT TECHNICAL DEVELOPMENTS

Metal-Oxide Transistor

A new type of field-effect transistor was described at a recent I.E.E. Colloquium. In this device, conduction is by means of charged carriers induced in the surface of a semiconductor by an electrostatic field. The field is applied by imposing a voltage to an evaporated aluminium film which is insulated from the silicon by a layer of silicon dioxide. The conduction path is between two diffused areas in the silicon. An input impedance of $10^{13}\Omega$ in parallel with 2-5pF is obtained, the g_m lying between 1 and 5mA/V.

Glass Fibre Microwave Aerial

The extreme accuracy of surface contour required for optimum performance in a dish aerial is difficult to obtain with normal methods of sheet-metal fabrication. A considerable degree of simplification and gain in strength/weight ratio has been achieved by the Marconi Company in a new method of construction, using glass fibre and "CRYSTIC" polyester resin, manufactured by Scott Bader and Co., Wollaston, Wellingborough, Northants. The necessary degree of surface finish is obtained by stretching steel wire mesh over an epoxide-coated concrete former. Glass fibre is laid over the mesh, and the whole impregnated by resin, which completely encloses the steel mesh. Further layers are bonded on, steel anchoring plates being let in during construction. The main features of these dishes are their accuracy (±0.03in on the true profile), high stiffness/weight ratio and comparative immunity to climatic extremes. At 7000 Mc/s, the aerials possess a gain over an isotropic radiator of over 44dB, the beamwidth being 0.9 degrees at −3dB.



Marconi 10ft diameter glass-fibre aerial. Centre-feeding can be used, but front-fed type is shown here.

Sensitive Storage Camera Tube

In the fields of astronomy and space research, there has been considerable need for a television camera to detect and store very faint images. Long exposures to light or other radiation can then be made, the image being stored and transmitted to base by a slow read-out. R. S. Filby *et al* described, in the issue of *Nature* for February 22, 1964, a tube which is sensitive, can store an image for several hours, and which does not exhibit the "lag" which is a common failing of tubes with larger target capacities and photoconductive layers. The novel feature of the tube is the construction of the target, which consists of a thin layer (500Å) of aluminium oxide supporting the signal plate of aluminium. On the side of the signal plate remote from the photocathode is a spongy layer of potassium chloride of a density about 3 per cent of that of the solid and about 10 micrometres thick. Electrons penetrate the spongy layer, building up a positive charge by transmission secondary emission; the secondary electrons are collected by a mesh a short distance from the target. The large thickness of the spongy layer gives a low capacitance and avoids lag. The positive charge image, which is about 10 times that of the image orthicon, is read out by a low-velocity beam and the signal obtained from the conducting signal plate.

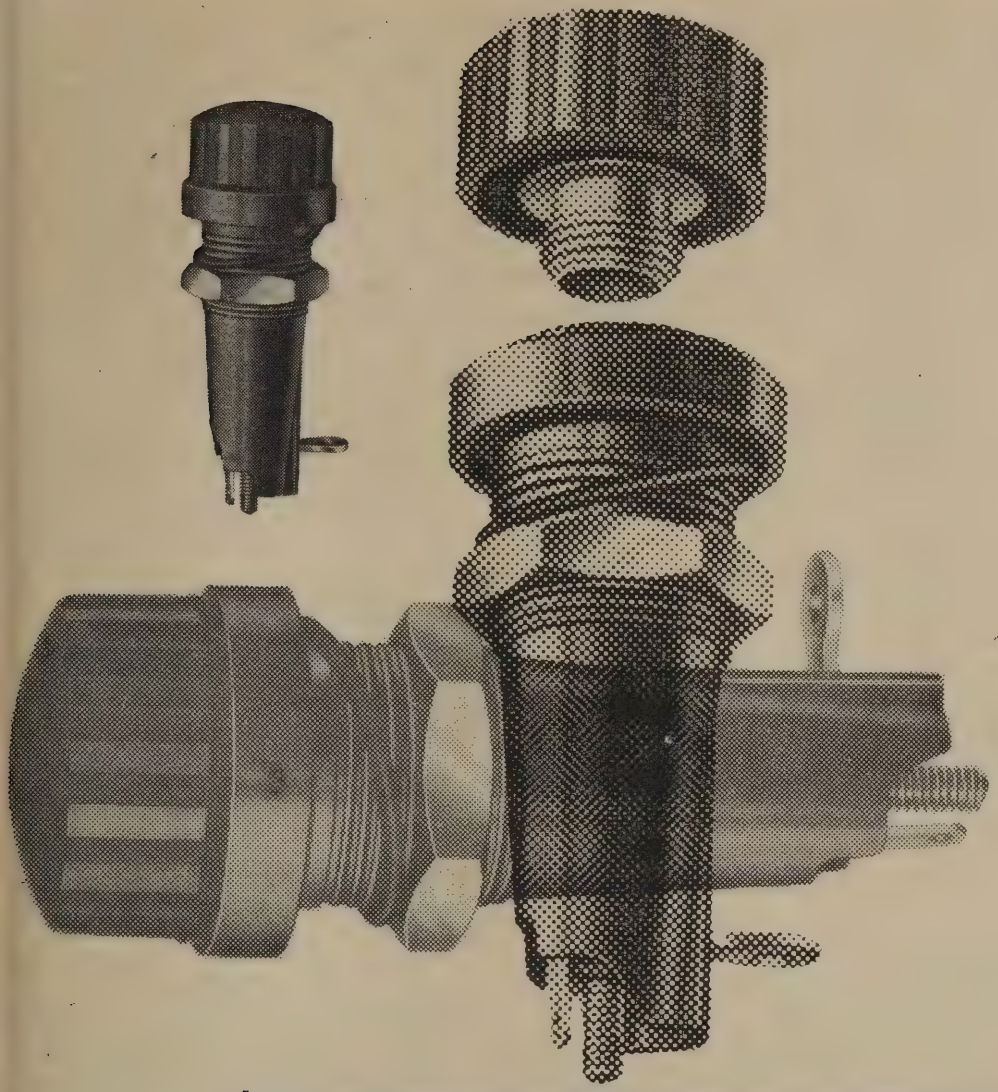
Transistor Assembly

A new technique of assembling transistors has been developed by S.T.C. Conventionally, the semiconductor wafer is first welded to the sealed lead assembly, followed by separate, intricate operations to connect the electrodes to the lead-out wires by very thin contact wires. In the new process, the silicon planar epitaxial structure has been modified to enable contact to be made with collector, base and emitter from one side of the wafer. A metal flash, followed by a coating of solder, is applied to each contact area and the completed wafer is dropped, contacts downwards, on to the lead-out wires. A brief heat treatment forms the three welds and the transistor is complete, except for encapsulation. The first type to be made by this process is the BSY95 switching transistor.

The S.T.C. BSY95 made by the new process.

C.R.T. for Character Generator

Alphanumeric characters used in displays of navigational and tabular information are usually generated by tracing them out dot by dot or by segments. To obtain greater brightness or speed, it is necessary to illuminate each element of the character at the same time. The Matricon, on which a paper was presented at a recent I.E.E. Colloquium, is a device intended to produce a speed × brightness factor of about 20 times greater than in the normal method. A quarter-inch square cathode has a parallel control electrode a short distance away, at or slightly above cathode potential. The control electrode is perforated with a 7 × 5 matrix of holes, and the beam is split into 35 parallel rays. These may pass through an insulating plate with 35 holes in it containing metal tubes, leads being taken from each tube to pins at the tube base. Positive or negative voltages on the pins pass or reject the rays, and characters are formed.



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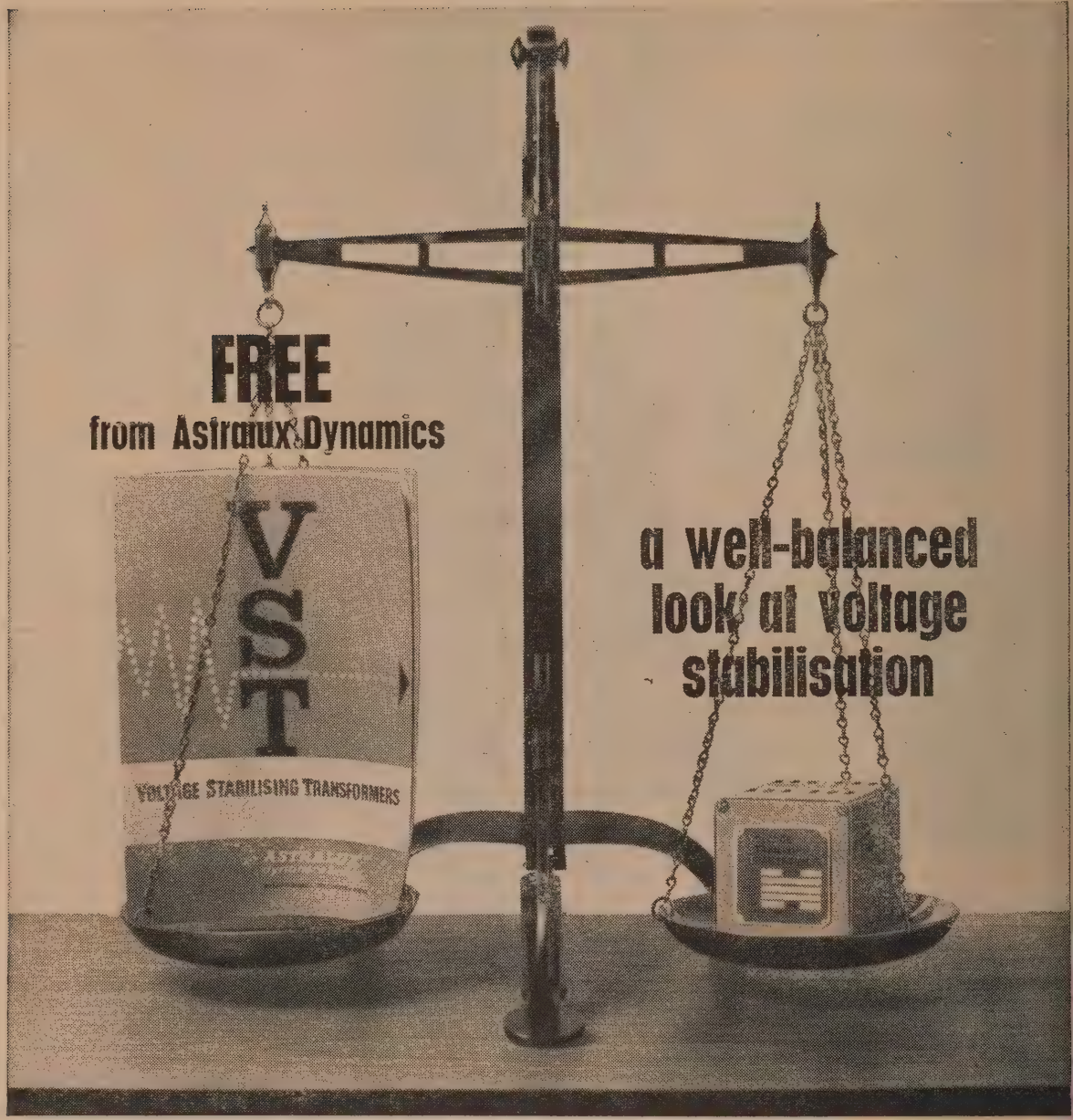

VST patent application numbers 3835 & 3836/64

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WORLD OF WIRELESS

Local Broadcasting

IT will be recalled that the Pilkington Committee recommended that a system of local sound broadcasting should be introduced in this country under the B.B.C's control. The Government has said that before deciding it wished to take cognizance of public reaction, but the fact is that the public has had no experience of local broadcasting, for all the pilot schemes tried by the B.B.C. have been on closed circuit.

The B.B.C's Director of Sound Broadcasting, Frank Gillard, recently stated in an interview that "what the B.B.C. would very much like to do now—as the next step—is to introduce a system of, say, half a dozen stations, on the air, in different centres, well chosen, in different parts of the country, and to run those stations for, say, a year, or even two years, experimentally, to see first of all whether the people who lived in those communities welcomed local broadcasting, and secondly, whether our ideas on the sort of programmes we should like to put on the local stations are worth while. I think it's a service which we certainly ought to introduce in this country, and one which would prove to be extremely valuable."

Television Award

THE first presentation of the Geoffrey Parr Award was made by Mrs. F. E. Parr, widow of "G.P.", at the annual dinner of the Television Society on 8th May. It was received by Peter Rainger on behalf, as he said, of his team in the B.B.C. Designs Department in recognition of their work on the electronic standards converter described in our October 1963 issue. No camera or display tubes are used in the new system which depends on electronic analysis of the 625-line picture and its re-synthesis at 405 lines.

The award, which has been introduced to commemorate the work of the late Geoffrey Parr who was secretary of the Society for many years, is to be presented annually "for an outstanding contribution to television engineering or an associated science". When receiving the award Mr. Rainger made special reference to the work of L. G. Davis and G. A. Hunt who are members of the team.

Hong Kong, which has had a wired television service operated by Rediffusion since 1957, is now to have a commercial television broadcasting station. The new service will operate on 625 lines and will provide both English and Chinese language programmes.

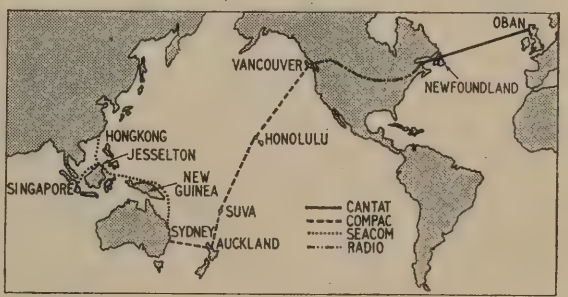
R.E.C.M.F. Officers.—The 1964/65 council of the Radio and Electronic Component Manufacturers' Federation consists of the following representatives of member firms:—R. Arbib (Multicore), C.M. Benham (Painton), E. E. Bivand (S.T.C.), S. H. Brewell (Hunt), N. D. Bryce (Belling & Lee), R. A. Bulgin (Bulgin & Co.), R. F. Collinson (Colvern), B. E. G. Harris (Bakelite), F. W. Irons (McMurdo Instrument), Dr. F. E. Jones (Mullard), E. G. Lennard (Cosmocord), Dr. G. A. V. Sowter (Telcon Metals), J. D. Sutton (Parmeko), and J. Thomson (Morganite Resistors). At the first meeting of the council Mr. Thomson was re-elected chairman, Mr. Brewell was elected deputy chairman, and Dr. Jones and Dr. Sowter vice-chairmen. Mr. A. F. Bulgin is continuing as president of the Federation, with K. G. Smith (N.S.F.) and E. E. Webster (Plessey) as vice-presidents.

Colour Transmissions.—The 625-line u.h.f. field trials of N.T.S.C. colour television from the Crystal Palace station on Channel 33 (the BBC-2 channel for the London area) are being transmitted for two half-hour periods daily. The times are as follows: Mondays, Thursdays and Fridays 12.0 to 12.30 p.m. and 4.30 to 5.0 p.m.; Tuesdays and Wednesdays 4.30 to 5.0 p.m. and 11.0 to 11.30 p.m. All the transmissions are asynchronous.

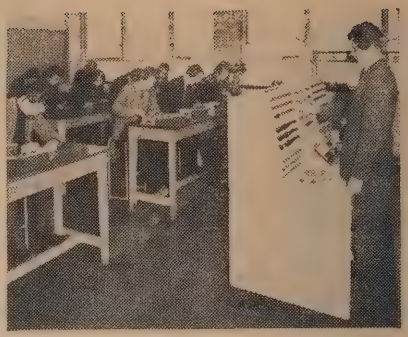
Extension of Test Transmissions.—The trade test transmissions from the BBC-2 London station will be extended during the next few months to assist the radio trade with the installation of aerials and receivers. The new schedule is: 9.30 a.m. to 1.0 p.m. and 2.0 p.m. to 6.0 p.m. Mondays to Saturdays inclusive. The material transmitted will consist of test card with tone or recorded music.

B.E.A.M.A. Electronics Board.—In accordance with its new divisional structure, the British Electrical & Allied Manufacturers' Association announces the formation of the electronics division, the constituent parts of which are the industrial electronic equipment section, the semiconductor devices section and the X-ray apparatus section. The electronics board has been reconstituted under the chairmanship of G. S. C. Lucas (A.E.I.), and the other members are: W. Gregson (Ferranti); R. J. Clayton (G.E.C. Electronics); John Collins (English Electric); G. E. C. Fairbanks (Elliott-Automation); W. Padley (Metal Industries); L. E. Thompson (Westinghouse); A. J. Minns (Watson & Sons Electro-Medical) and D. Edmundson (A.E.I.).

Arabian Station.—Nearing completion at Salt Pans, near Aden, is a new £250,000 wireless receiving station which is being built by Cable & Wireless (Mid East) Ltd. It will work as a sister station to the nearby transmitting station at Hiswa equipped with 28 transmitters, and will provide direct telephone and telegraph links with the U.K., Africa and the East as well as serving as a relay centre on the London-Far East routes. It will also provide a ship-shore service.



Canada's *microwave network linking the Canadian Trans-Atlantic telephone cable (Cantat) with the Commonwealth Trans-Pacific telephone cable (Compac) was officially opened on 11th May, by the Canadian Minister of Transport. This project, which links Montreal on the east coast with Vancouver on the west, has been built jointly by Canadian Pacific and Canadian National Telecommunications at a cost of $41M (about £14.6M). It is Canada's second radio link between the east and west coast cities and will ultimately provide eight radio channels, each of which can carry 600 telephone circuits. Some 130 stations are used in the 3,282-mile radio path.*



Aberdeen's *new £1.5M Technical College provides places for some 3,500 students in forty different professions. In the electrical engineering department is a section providing instruction for prospective marine radio officers. On the left students are receiving instruction in servicing and on the right students are receiving Morse under simulated sea-going conditions. Marconi Marine equipment is used.*

The B.B.C.'s new television and v.h.f. sound relay station at Ward of Bressay, near Lerwick, to be known as the **Shetland Transmitting Station,** was brought into service on 15th April. Television transmissions are radiated in Channel 3 with vertical polarization, and the three sound programmes are radiated with horizontal polarization, on the following frequencies: 88.3, 90.5 and 92.7 Mc/s. A receiving station has been built at Fitful Head to pick up the programmes from the B.B.C.'s Orkney transmitting station. The television programme is then fed over a microwave link to the transmitting station at Ward of Bressay; the three sound programmes are carried by Post Office line. This new station brings B.B.C. television and the v.h.f. sound programmes within reach of about 17,000 people in the Shetlands for the first time.

Sydney, Australia, is to have its third commercial television station next year in addition to the station operated by the national Australian Broadcasting Commission. All Australia's existing 42 stations operate in the v.h.f. band. There are now nearly two million television licences in the country which represents a set for every six people.

Broadcast Receiving Licences.—There was an increase of 95,848 combined television and sound licences in the U.K. during the first quarter of this year. The end-of-March figures were:—sound only 2,999,348 (including 576,621 for sets fitted in cars) and combined TV/sound 12,885,331; making an overall total of 15,884,679.

Eavesdropping.—New regulations proposed by the American Federal Communications Commission would ban the use of transmitting equipment for the purpose of recording or overhearing private conversations. According to our New York contemporary, *Radio-Electronics*, this apparently late action has been necessitated by the advent of miniature battery-operated transmitters, smaller than a pack of cards.

Band V—The German Post Office has announced that frequencies between 790 and 860 Mc/s, which are within the television Band V, will be used for other services—mainly for "fixed" stations.

OUR COVER

In the centre of a selection of equipment to be seen at the I.E.A. Exhibition is a Via-Vac combined sputtering and evaporation unit used for the production of thin film circuits at an S.T.C. factory. The remaining photographs have also been used in illustrating our preview.

Northern Ireland is to have its on Radio, TV and Electronics Exhibition. It is being sponsored by the Northern Ireland Radio Retailers' Association and will be held in the King's Hall, Balmoral, Belfast, from 14th-21st October.

European V.H.F. Sound Broadcasting.—Nearly 2,300 transmitters, of which over 1,250 are in Italy, are listed in the latest edition (No. 9) of the "List of v.h.f. sound broadcasting stations" in the European area issued by the European Broadcasting Union. The country with the next highest number of transmitters is West Germany with 194. The 78-page geographical list giving the location and operating characteristics of the stations costs 100 Belgian francs and this includes six bi-monthly amendments.

A symposium on **sonic investigations** of internal damping in solids will be held in the Physics Department of Imperial College, London, from 5th-7th August. It is being organized by the Acoustics Group of the Institute of Physics & Physical Society.

Reliability—A three-day course on the principles of electronic equipment reliability will be held at the Borough Polytechnic, London, S.E.1, from Tuesday, 23rd June (Fee £6).

An international conference on **Magnetic Recording** is to be held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2, from 6th to 10th July. The conference has been divided into six categories to cover audio, video, digital and analogue techniques, recording media, and general problems. The meeting is sponsored by the I.E.E., the I.E.R.E. and the I.E.E.E. and a technical exhibition is being held during the conference.

"Thames Navigational Service."—The Gas Accumulator Company (U.K.) Ltd., ask us to supplement the information given on p. 218 of the May issue about their tide recorders at Shivering Sands Fort. The battery-operated transistor transmitter linking the recorder at the Fort with Southend Pier was provided by Microwave Associates Ltd., and the links with Southend and Tilbury to Gravesend by Pye Telecommunications Ltd.

A new 28-frame colour filmstrip entitled **"A.M. Receivers"** is now available from the Mullard Educational Service distributors, Unicorn Head Visual Aids Ltd., 42 Westminster Palace Gardens, London, S.W.1. The strip briefly describes tuned radio-frequency and super-regenerative receivers, and covers in some detail the r.f. and i.f. stages of the superhet receiver. It concludes with a number of practical receiver circuits. Price 25s per strip, including comprehensive teaching notes.

PERSONALITIES

Sir Harold Bishop, C.B.E., B.Sc. (Eng.), who retired from the post of Director of Engineering, B.B.C., last year, has joined the board of the International Research and Development Company of Newcastle-upon-Tyne. Sir Harold is deputy chairman of the Telegraph Condenser Company and a consultant to the British Insulated Callender's Cables group of companies.

A. J. King, M.Sc.Tech., D.Sc., M.I.E.E., F.Inst.P., who recently became consultant on acoustics to the Research Laboratory of the A.E.I. Power Group, has been appointed a part-time reader in applied acoustics at the College of Science and Technology, Manchester. Dr. King began work on acoustics in the Research Department of the Metropolitan-Vickers Electrical Company in 1926 and has been in charge of the Acoustics Laboratory at Manchester since 1928.

Leonard G. Dive, A.M.I.E.E., A.M.I.E.R.E., senior assistant in the B.B.C's Engineering Information Department for the past ten years, is going to New York as senior engineer in the Corporation's United

L. G. Dive

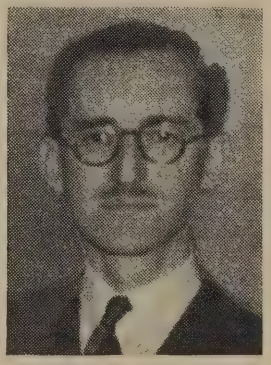
States office in succession to **D. A. V. Williams,** B.A., A.M.I.E.E., who has completed his two-year tour of duty. Mr. Dive joined the B.B.C. 20 years ago as a maintenance engineer at the Tatsfield Receiving and Measurement Station. In 1945 he became station instructor for both Tatsfield and the Monitoring Station at Caversham Park, near Reading. In 1947 he was appointed lecturer in the Engineering Training Department at Wood Norton, Worcs., where from 1951-54 he was deputy senior lecturer.

W. Proctor Wilson, C.B.E., B.Sc.(Eng.), F.C.G.I., M.I.E.E., head of the B.B.C's Research Department since 1950, is retiring at the end of July. After working with the Western

W. Proctor Wilson

Electric Company (now S.T.C.), Mr. Wilson joined the B.B.C. in 1927. Three years later he left to join Marconi's but returned in 1933 to rejoin the Research Department. Throughout the war he served in the Signals Branch of the R.A.F., first as an assistant air attaché in Paris and later (1941-45) as chief engineer of No. 60 (Signals) Group with the rank of group captain. He returned to the B.B.C. in 1945 as assistant head of the Research Department.

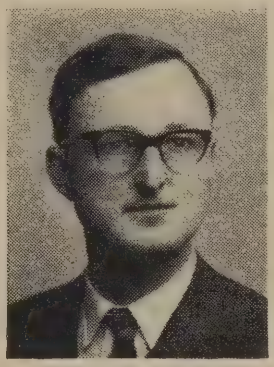
G. G. Gouriet, M.I.E.E., who left the B.B.C. in 1958 to join the board of Wayne Kerr Laboratories as technical director, is returning to the Corporation to become head of the



G. G. Gouriet

Research Department in succession to Mr. Wilson. Mr. Gouriet, who is 46, joined the B.B.C. in 1937 and after five years in the Operations and Maintenance Department transferred to the Research Department where he was head of the television group when he left. Although he has specialized in television research and more especially colour systems, Mr. Gouriet's interests include information theory, and measurement and control problems.

P. A. C. Morris, B.Sc., A.M.I.E.E., has joined Granger Associates Ltd., of Weybridge, the recently formed British subsidiary of the Californian company of the same name which



P. A. C. Morris

manufactures oblique incidence sounders, log periodic aerials and other specialized communications equipment. Mr. Morris, who has frequently contributed to *Wireless World* on h.f. propagation, is a graduate of Leeds University (1953) and served his apprenticeship with Edison Swan before joining Cable & Wireless in 1957. For the past five years he has been in charge of the radio propagation section of the engineer-in-chief's department. Mr. Morris has, for some time, represented C. & W. on study groups of the C.C.I.R. concerned with ionospheric and tropospheric propagation.

R. J. F. Keir, O.B.E., B.Sc., A.M.I.E.E., has recently returned to Singapore for a second tour of duty as resident engineer of the B.B.C's Far Eastern Station at Tebrau. He returned to this country in 1961 after spending nearly five years in the Far East and for the past three years has been engineer-in-charge of the short-wave transmitting station at Skelton, Cumberland, where **T. E. Lowry** is, for the present, acting e.-in-c.

John R. Trost, B.Sc., A.M.I.E.E., who since 1958 has been leading a team engaged in the design and development of radar projects at the Gt. Baddow Research Laboratories

John R. Trost

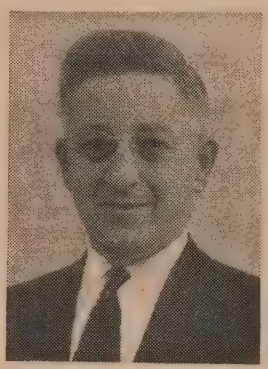
of the Marconi Company, has been appointed deputy technical manager of the Marconi International Marine Company. He succeeds **G. N. Bowling,** who recently left to become managing director of Brookdeal Electronics. Mr. Trost joined Marconi's in 1944 as a design engineer after studying at the Brighton Technical College.

Tom Goddard, an employee of Standard Telephones and Cables Ltd. at Harlow, Essex, has received a cheque for £625, as an award under the company's employee suggestion scheme. Mr. Goddard, who has been with the company for 28 years, received his award for suggesting a modification to a manufacturing procedure in the quartz crystal division. He has had six other suggestions accepted, one of which won him £100.

Fellowship of the Television Society, which is conferred on those who have "achieved eminence or made outstanding contributions to the science, technology or art of television," has been awarded to **S. N. Watson,** M.I.E.E., head of the B.B.C's Designs Department, **P. A. T. Bevan,** C.B.E., B.Sc., M.I.E.E., chief engineer of I.T.A., and **W. E. Turk,** A.M.I.E.E., manager of the photoelectric tube division of the English Electric Valve Company. Mr. Watson has been with the B.B.C. since 1933 and joined the Designs Department in 1947. Mr. Bevan was in industry prior to joining the B.B.C. in 1934 and was senior planning engineer when he left in 1954 to become the first chief engineer of I.T.A. Mr. Turk joined the E.M.I. Research Laboratories in 1936 where he stayed until 1953 when he joined the E.E. Valve Company. He has been in charge of the photoelectric tube division for seven years.

R. H. Wood, M.V.O., the B.B.C.'s engineer-in-charge of outside broadcasts (sound), London, has retired after over 40 years' service. Mr. Wood joined the B.B.C. in 1923 as a maintenance engineer at Manchester and became e.-in-c. there the following year, before moving to Chelmsford to take up the post of assistant e.-in-c. of the team working on the experimental transmitter 5XX. In 1925, Mr. Wood was appointed assistant e.-in-c. London outside broadcasts; he has been e.-in-c. since 1935. Mr. Wood was made a member of Royal Victorian Order in 1946 by King George VI in recognition of his services to the Royal Family over many years in connection with Royal broadcasts.

P. E. Leventhall, B.Sc.(Hons.), M.I.E.R.E., who joined the Cossor Group nine months ago as v.h.f. group leader, has been appointed chief engineer of the Cossor Communications Company. Prior to



P. E. Leventhall

joining Cossor's he was, for five years, with the Rank-Bush-Murphy organization where he was chief engineer of the radiotelephone division.

R. G. Robertshaw, who joined the G.E.C. research laboratories as a technical assistant in 1940, has been appointed technical manager of the M-O Valve Company. In recent years he has specialized in the research and development aspects of special magnetrons, travelling wave tubes and other microwave devices at the Hirst Research Centre, Wembley. **E. Kettlewell,** who also comes from the Hirst Research Centre, has been appointed the M-O Valve Company's development manager. Mr. Kettlewell joined the scientific staff of the G.E.C. research laboratories in 1936 and spent four years on the development of high pressure mercury lamps before turning his attention to radar systems. In 1943 he transferred to the microwave valve group.

D. W. Heightman, M.I.E.R.E., who has been connected with Goodmans Industries Ltd. for several years and a director of the company for the past two, has been appointed joint managing director with **M. H. C. Lewis.** Mr. Heightman resigned from Denco (Clacton) Ltd., a company which he formed before the war, to become chief television engineer of English Electric's Liverpool works in 1951. Five years later, Mr. Heightman joined Radio Rentals Ltd. as chief engineer and was appointed to the board, as technical director, in 1960. He relinquished this post in 1962.

K. E. Owens recently joined the board of Livingston Laboratories Ltd. and has been appointed general manager of their establishment at Camden Road, London, N.W.1. Mr. Owens was formerly manager of the Broadcast and Recording Equipment Division of E.M.I. Ltd.

OUR AUTHORS

R. H. Bradsell, joint author of the article describing a u.h.f. test oscillator in this issue, has worked in the Standards Division of the National Physical Laboratory since 1949. He did the early research on a photoelectric micrometer microscope which was subsequently developed and went into commercial production. More recently he has been interested in the velocity of light as a basis for a length standard and in the use of microwave techniques to produce an electronic measuring device for geodetic distances. His collaborator, **M. Grimshaw,** joined the Standards Division from college in 1962 and has been working in the field of length measurement and moiré fringe techniques and has worked with his co-author on u.h.f. semiconductor devices.

A. T. Bayliss, who has been senior lecturer in radio communication at the College of Technology, Oxford, for the past 17 years, writes in this issue on the tunnel diode as a frequency divider. He received his technical training at the college where he now teaches and during the war served as a signals/radar officer in the R.A.F.

OBITUARY

T. P. Lynott, A.M.I.E.E., chief engineer of Gardners Transformers Ltd., of Christchurch, died on 2nd May, aged 49. Mr. Lynott joined Gardners as chief engineer in 1957, having previously been for ten years at A.E.R.E., Harwell, where he was head of the transformer section in the Electronics Division. He was at one time in the directorate of instrument production in the Ministry of Supply.

Tunnel Diode Frequency Divider

RELIABLE OPERATION AT HIGH DIVISION RATIOS

By A. T. BAYLISS, A.M.I.E.E.

MULTIVIBRATORS using either valves or transistors have been widely used as frequency dividers, but the maximum reliable frequency division does not exceed a factor of ten in these circuits.

The precision with which a tunnel diode multivibrator can be synchronized allows much higher division ratios to be achieved.

A consideration of the basic action of the tunnel diode multivibrator will indicate how this precision is obtained. Consider the circuit of Fig. 1. The tunnel diode is biased into its astable region on the negative-resistance portion of the characteristic shown at (1) in Fig. 2. The slope of the load line (1) is the resistance of the source plus the resistance of the inductance L. Any random fluctuation of current will produce an e.m.f. in the inductance which will carry the circuit into a semi-stable state and a relaxation oscillation occurs. Commencing at

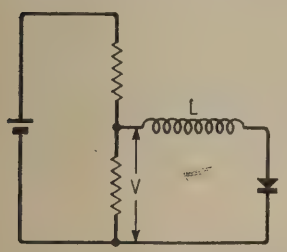


Fig. 1. Elements of tunnel diode oscillator circuit.

point A with voltage rising towards V, the current will tend to decrease as the negative resistance region is entered. The inductance will, however, maintain the current through the diode nearly constant and an e.m.f. E_L is induced which transfers the load line to B. This e.m.f. now falls at a rate decided by the time constant of the circuit L/R_{eq} where R_{eq} is the source resistance, the coil resistance and the forward resistance of the diode from C to B. With this decaying e.m.f. point C is reached where current starts to rise. Again an e.m.f. is induced which transfers the load line to D, again holding the diode current nearly constant. The current in the tunnel diode rises to A at a rate dependent on the time constant of the circuit, and the cycle of events is repeated. The voltage waveform across the diode is shown in Fig. 3.

Positive going pulses are now introduced across the tunnel diode via C and R to synchronize the multivibrator as in Fig. 4.

The slope resistance of the diode from D to E, Fig. 2, is very low compared with the resistance R, so that the synchronizing pulses occurring during this time interval when the current is rising from D to E are almost entirely suppressed. Between E and A the incremental resistance sharply rises

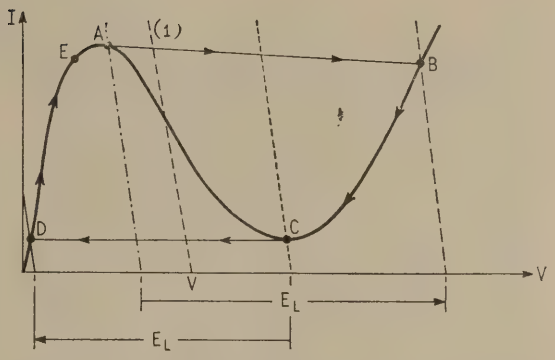


Fig. 2. Locus of operating point in circuit of Fig. 1.

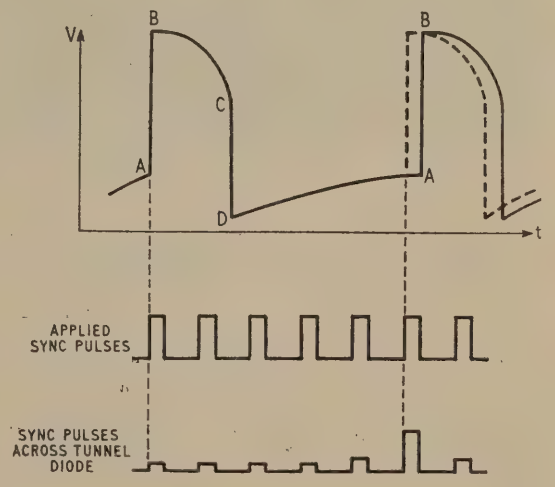


Fig. 3. Operation as frequency divider, showing division by 5.

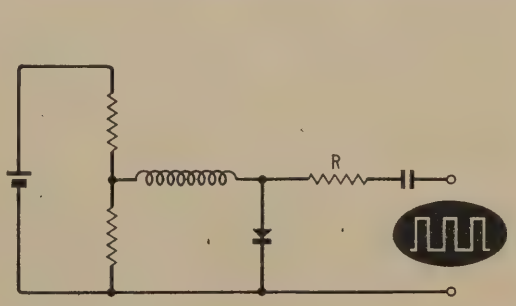


Fig. 4. Method of introduction of sync. pulses. R is large compared with initial slope resistance of tunnel diode.

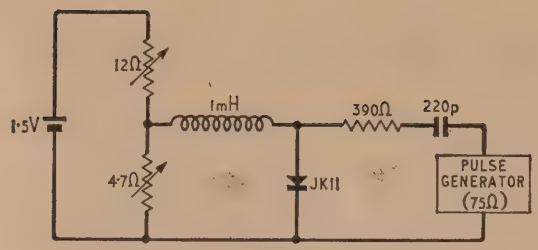


Fig. 5. Circuit used to measure divider performance.

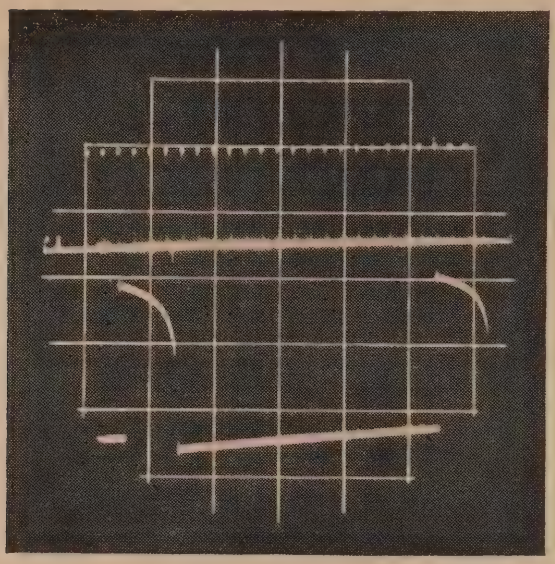


Fig. 6. Division ratio of 20 : 1 from circuit of Fig. 5.

allowing a positive pulse to lock the multivibrator before the critical point at A is reached. The dotted wave form in Fig. 3 shows the triggering of the divider by every fifth sync. pulse. Synchronizing pulses occurring during a time interval from B to C are likewise suppressed. The suppression of the unwanted synchronizing pulses is shown.

A practical circuit (Fig. 5) using an S.T.C. JK11 germanium tunnel diode has been set up to measure the division ratios obtainable. Positive-going, 1 μsec., 0.5V amplitude pulses of varying repetition frequency were obtained from a pulse generator with a 75 Ω output impedance. The waveforms of the sync. pulses and the voltage across the tunnel diode were observed on an oscilloscope with the results shown in accompanying oscillogram, showing a frequency division ratio of 20:1. The highest division ratio measured was 40, but there seems to be no reason why this could not be increased. Significantly, the amplitude of the synchronizing pulse could be varied through a range of 3:1 without upsetting the frequency division. With the circuit values as above, the fundamental frequency of the multivibrator was 6.7 kc/s.

Possible Television Timebase Circuit

The automatic suppression of the unwanted trigger pulses might profitably be exploited in the line time base generator of a television receiver. The line time base oscillator could be a tunnel diode multivibrator locked in the normal way by the positive going line sync. pulse from the sync. separator. Any impulsive noise in the output of the sync. separator would be suppressed in the same manner as the unwanted trigger pulses are suppressed in the frequency divider. The circuit might then be a possible alternative to the more complex flywheel sync. circuits now in use.

"AQUILA'S" 75TH ANNIVERSARY

Work of the Electrical Inspection Directorate

IT was in 1889 that is was decided to divorce inspection from the functions of other Government departments supplying the needs of the Armed Forces, and the present Electrical Inspection Directorate (motto, *Aquilae Oculo*, "with the eye of an eagle") stems from the Ministry of Aviation's Board of Inspection, the other branch being the Aeronautical Inspection Directorate.

The work of E.I.D. now covers a wide field, including radar, signals, navigation systems, electronic components and aircraft electrical systems. In addition to Electronics (L) and Power and Instruments (P. & I.) there are divisions for Atomic Weapons (AW) and Engineering Services (ES), the latter providing common technical services for the other divisions.

The E.I.D. is administered from Bromley, Kent, but has regional headquarters also in Glasgow, Manchester, Birmingham and Bristol, since much of its work is done in the field. The work of the electronic division is by no means confined to the test bench as the accompanying photograph shows. Here the profile of a precision radar scanner is being checked on site for mechanical distortion, which might give rise to side lobes.

If your H.F. radiotelephone circuits are pushed to the limit or if you find new planning difficult—**you need Rediplex for maximum utilisation and lower operating costs.** Now for the first time, **at low capital cost,** Redifon introduce a compact ISB multi-channel system for short and medium distance communication. Four speech channels simultaneously using one carrier. The cost of the transmitting and receiving terminals, including the channelling, is far less than you would pay for regular channelling and displacement equipment—a quickly installed packaged deal. It will pay you to find out more about Rediplex. Write now for full specifications.

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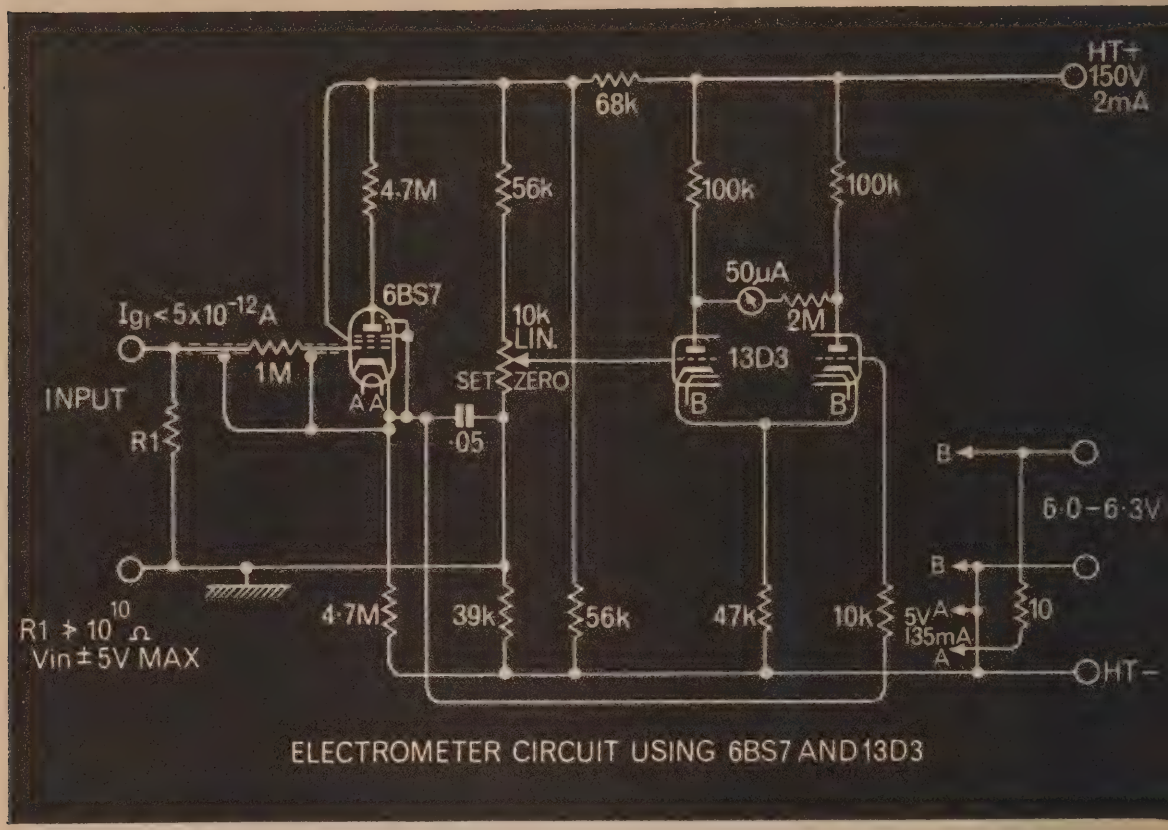
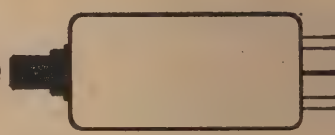
Rx2

BRIMAR 6BS7



ELECTROMETER CIRCUIT USING 6BS7 AND 13D3

electrometer pentode



The BRIMAR 6BS7 screened pentode is ideal for electrometer use, or for other special applications, including very high gain audio input circuits, where its characteristics of low noise, microphony and hum are necessary. Shown above is a typical electrometer circuit using types 6BS7 and 13D3. Please ask for Data Sheets

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U.H.F. OSCILLATOR

A SIMPLE INSTRUMENT SUITABLE FOR TELEVISION (BAND IV) TESTING

By R. H. BRADSELL and M. GRIMSHAW*

THE u.h.f. oscillator described was the by-product of a research programme carried out by the authors in connection with the NPL mekometer[1,2], an electronic distance measuring device. A signal source was required for the design and testing of 600 Mc/s cavity resonators used in the final stages of a crystal-controlled u.h.f. frequency standard for the mekometer. The unit produced for this purpose was compact and so simple in design and construction that it was felt to be of wide interest. The advent of u.h.f. television broadcasting in the London area on Channel 33, Band IV (567.25 Mc/s vision, 573.25 Mc/s sound) opens up a need for just such an instrument.

A general view of the oscillator is given in Fig. 1 and it can be seen that the unit is quite small, in fact only $4\frac{1}{2}\times3\frac{1}{2}\times2$ in. Complete screening is provided by the die-cast box used to house the equipment.

Circuit Description

The circuit diagram is given in Fig. 2. The circuit utilizes a shunt-fed Hartley oscillator based on the A2521 grounded-grid triode. This valve has a high mutual conductance and can be used at frequencies up to 1250 Mc/s. It is a conventional miniature valve using the B9A base.

The tank circuit employed in the oscillator is the coaxial-line resonator shown in Fig. 3 which has a mid-frequency of about 570 Mc/s. Two tapping points are made on the inner conductor for the anode and cathode of the valve V1 to give correct phasing for oscillation.

A coaxial line, which is a quarter wavelength long [3], is a resonant circuit. It has distributed inductance and capacitance and a characteristic impedance Z_0, where

$$Z_0=\sqrt{\frac{L}{C}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

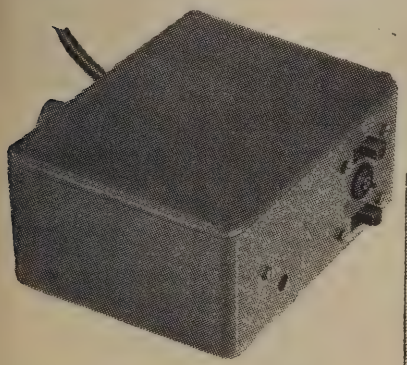
L is the inductance per metre and C the capacitance per metre.

The equation for Z_0 given by (1) can be expressed also in terms of the internal diameter D of the outer conductor and diameter d of the inner conductor of the coaxial line. The form of the equation is then

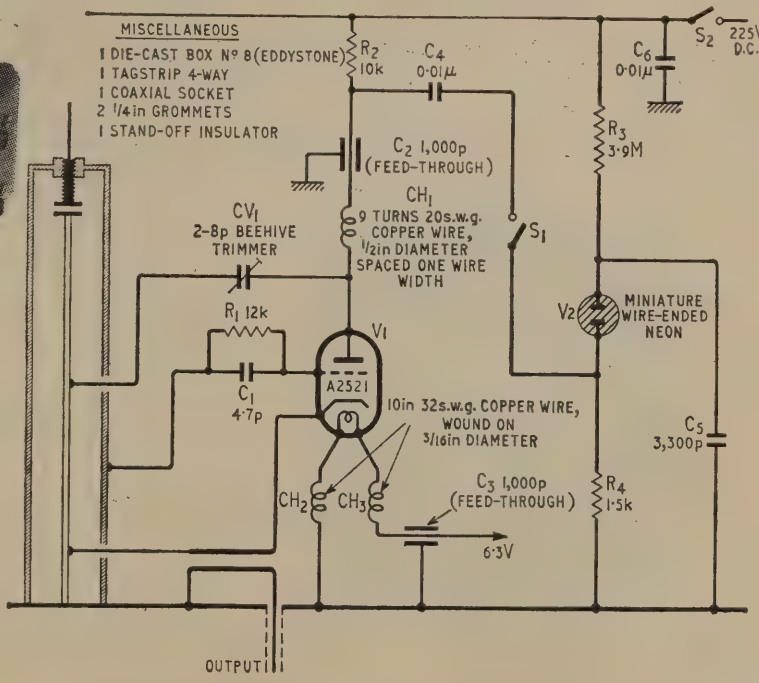
$$Z_0=138\log_{10}\frac{D}{d} \quad \ldots\ldots\ldots\ldots \quad (2)$$

If a coaxial line is shortened so that the length of its inner conductor is no longer a quarter wavelength at the desired frequency of operation f, it is no longer

* National Physical Laboratory, Teddington, Middlesex.



Above: Fig. 1. U.h.f. test oscillator.



Right: Fig. 2. Circuit diagram of the equipment.

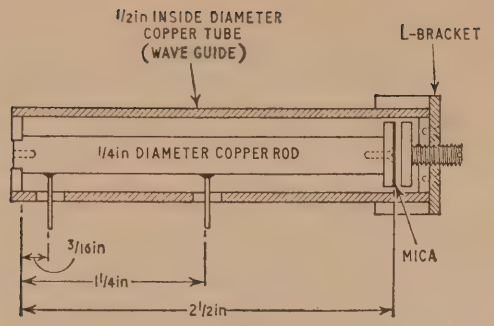


Fig. 3. Details of coaxial cavity resonator.

purely resistive but exhibits an inductive reactance at the open end. If a capacity C, of the correct value, is added across the open end of the line this inductive reactance is tuned out and the coaxial resonator will again resonate at the desired frequency *f*.

The following equation can be used to find C for a given length of line,

$$\frac{1}{2\pi fC} = Z_0 \tan\left(\frac{2\pi l}{\lambda}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where l and λ are the length of the inner conductor of the coaxial line and the wavelength respectively.

As can be seen from Fig. 3 the coaxial-line resonator used in the oscillator has capacity and loading in the manner described above. The capacitor C is made from two $\frac{7}{16}$ in diameter copper discs which form an adjustable parallel-plate capacitor. The inner conductor is prepared from $\frac{1}{4}$ in diameter copper rod and the outer conductor from $\frac{1}{2}$ in internal diameter copper tube.

It has been shown that the coaxial line in this form can be looked upon as an inductance. The anode of the triode V1 is tapped into this inductance which acts as an auto-transformer allowing the cathode to be tapped in at a suitable impedance near the bottom of the line. The grid is connected to a point on the outer sheath of the coaxial line, via the grid-leak bias network formed by R_1 C_1 mid-way between the anode and cathode tapping points.

The anode load of V1 is the radio-frequency choke L_1 and the alternating current is coupled into the coaxial resonator by CV_1 which is used to adjust the feedback to ensure stable oscillation.

Supply decoupling is provided by R_2 and C_2 and the valve heater is fed through chokes CH_2 and CH_3 which isolate it from earth at the signal frequency.

The u.h.f. output from the oscillator is taken from a coupling loop which intersects the magnetic field in the short lead joining the cathode of V1 to its tapping point on the resonator.

It was felt that some simple form of audio modulation would be an added asset. To meet this requirement the miniature neon V2, which also acts as high tension indicator, was connected as a relaxation oscillator producing short pulses at about 400 per second. The pulse output is connected, via S_1, to the junction of R_2 C_2 which varies the h.t. supply voltage at the anode of V1 producing both amplitude and frequency modulation of the u.h.f. signal. This system, though simple, is adequate for most applications.

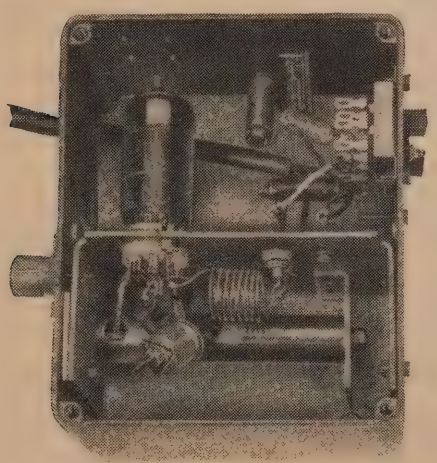


Fig. 4. General layout of components in the instrument.

Constructional Details

The instrument is assembled on a subchassis of brass which is a good fit into the die-cast box. The general layout can be seen in Fig. 4. Leads from the valve holder, which should be of a low-loss type, to the coaxial resonator must be as direct and short as possible. The five grid pins should be bent inwards and soldered to the central spigot of the valve holder, the resistor-capacitor pair R_1 C_1 being connected from the end of this spigot to the outer wall of the resonator. The two heater-lead chokes CH_2 and CH_3 should be positioned at right angles to CH_1 and this component should be well clear of the box lid when it is in position. The rest of the circuit is not critical.

The oscillator, when completed, can be tested initially by placing a milliammeter in the positive h.t. lead and reducing CV_1 to minimum value. The anode current should be approximately 16 mA. If CV_1 is now increased the current should drop suddenly to about 13 mA indicating oscillation. A further increase in CV_1 will ensure stable operation.

The frequency is set by adjusting the parallel-plate capacitor terminating the coaxial resonator. If this capacitor is set to too high a value the resonator is virtually shorted at the signal frequency and will operate, in the half-wavelength mode, at a much higher frequency. Should the test oscillator be required to operate at the low end of its frequency range and this fault found to occur, tuning capacitance can be added halfway down the inner conductor of the coaxial resonator by changing CV_1 for a fixed capacitor of about 33 pF.

With the resonator shown in Fig. 3 the frequency coverage is approximately 530 Mc/s to 600 Mc/s. Operation over other frequency ranges can be accomplished by redesigning the coaxial resonator.

The measurement of frequency is most easily accomplished, when an absorption wavemeter is not available, by means of a Lecher line. This comprises a pair of taut parallel wires forming an open transmission line and a bridge to short-circuit the wires. The oscillator is coupled by a loop to one end of the line and a simple loop-probe coupled by a crystal diode to a microammeter used to register the power output of the oscillator. The half-wavelength, and

hence the frequency, can be deduced from the distance between successive bridge positions for a " dip " in the output.

In conclusion we feel that the advent of u.h.f. television broadcasting will make this simple and reliable instrument useful to both amateur and professional engineers. It will also enable useful experience in u.h.f. technique to be gained at minimum cost.

The oscillator described was developed as part of the research programme of the National Physical Laboratory and this article is published by permission of the Director of the Laboratory.

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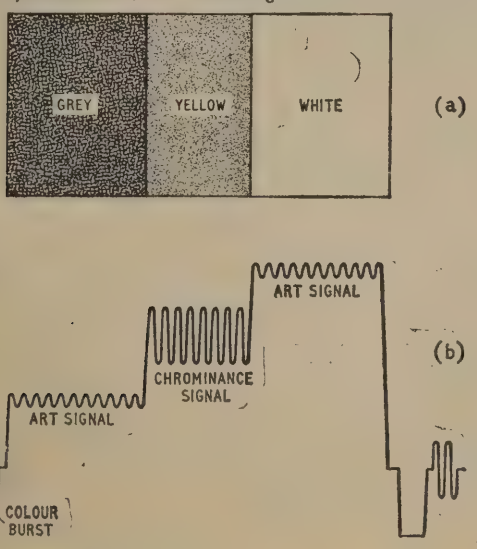
ART: A New Colour System

NOW that the C.C.I.R. has prolonged, until April 1965, the competition for a European colour television system, the way may be clear for latecomers to enter the field and—who knows?—perhaps carry off the prize. The latest system to attract serious interest has been put forward by Dr. N. Mayer of the Institut für Rundfunktechnik, in Munich.

Tests with the new system have shown it to be immune to differential phase distortion up to at least 40°, to be less susceptible than N.T.S.C. to multipath distortion, and to have at least the same protection against noise.

Dr. Mayer was led to his new system by reasoning that the principal criticisms of N.T.S.C. were, in one way or another, concerned with the susceptibility of the subcarrier signal to amplitude-dependent phase distortion (i.e. differential-phase). SECAM and PAL are relatively immune to this type of distortion, but need in the receiver both a delay line (64μsec) and an electronic switch operating at the line timebase frequency. Dr. Mayer decided to investigate what improvements could be made to the N.T.S.C. system if the receiver could also include a delay line and an electronic switch.

Fig. 1. Transmitted " picture " (a) and its video waveform (b) showing the ART signal. On any one line, during the transmission of the yellow bar, the ART signal and the normal N.T.S.C. chrominance signal merge into one subcarrier sine wave. The normal N.T.S.C. chrominance subcarrier is zero during greys and whites, but the ART signal is still transmitted.



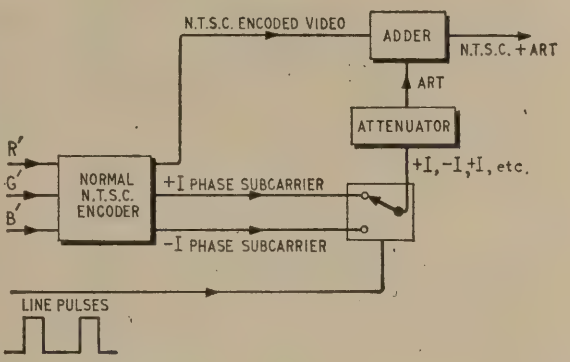


Fig. 2. Simplified block diagram of an N.T.S.C.-with-ART encoder.

So-called linear phase distortion is not particularly worrying in N.T.S.C., since the fundamental component of the chrominance subcarrier signal has the same frequency as the reference colour burst, and the relative phase between the two signals—which determines the reproduced hue—is unaltered. However, the reference burst is always at the black level of the composite signal, whereas the chrominance signal rides up and down on the varying-amplitude luminance signal. If the phase distortion is level-dependent, then the phase of the chrominance signal with respect to the colour burst will change, and this will change the colours of the reproduced picture. If the reference burst were to ride up and down on the luminance signal, together with the chrominance signal, then the relative phase between burst and chrominance could not be altered.

Dr. Mayer proposes that a new subcarrier reference signal should be added to the old N.T.S.C. signal, and that this should be present during the whole of the active part of each line scan, i.e. over all the picture area. He calls this new method of transmitting colour signals: N.T.S.C. with Additional Reference Transmission, which is abbreviated, naturally, to ART.

The additional reference signal is at N.T.S.C. subcarrier frequency precisely, and has the phase of the "I" signal, not of the colour burst. The phase of the additional reference signal is reversed from one scanning line to the next so that it is +I phase on one line and −I phase on the next, etc. At the beginning of every second field, however, the reversing switch is always set to the same polarity, since this improves the compatibility.

The dot pattern which such an additional reference signal produces on a monochrome receiver

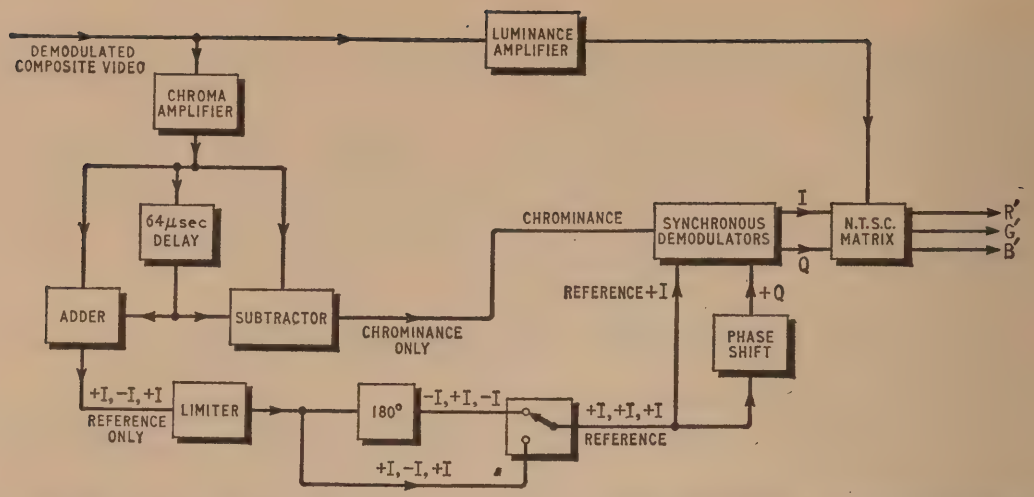


Fig. 3. One type of receiver decoder circuit for N.T.S.C. with ART. The output from the adder is twice the level of the I signal at its input.

screen is similar to that produced by a carrier at an odd multiple of line frequency, as distinct from the interlaced dots of the odd multiple of ½-line-frequency colour subcarrier. Experiments on carriers interfering with N.T.S.C. signals have demonstrated that such an interfering carrier becomes visible when its peak-to-peak amplitude is 24 dB with respect to the composite peak white signal. The p.t.p. amplitude of the ART reference signal is chosen to be 7% of the amplitude of the composite peak white signal, including sync pulses, i.e. 23 dB down.

Very little modification is required to normal type N.T.S.C. encoders in order to generate an ART signal. Outputs from the reference signal generator in the encoder, or feeding the encoder, are taken at 123° and −57°, i.e. ±I phases, and are alternately selected by an electronic switch operated by the line drive pulses. After adjustment to the correct, rather small, level, the ART signal is added to the normal output of the N.T.S.C. encoder.

Dr. Mayer reports that the compatibility of the ART composite signal is slightly worse than the normal N.T.S.C. signal, and several observers rated it at −1 grade (i.e. "slightly worse") on the E.B.U. comparative scale (Scale C).

The N.T.S.C. with ART signal will operate an N.T.S.C. colour receiver without any modification to its circuits, although the sensitivity of the receiver to hue changes produced by differential phase distortion in the signal path is then no better than for a normal N.T.S.C. transmission, since the standard colour receiver still derives its own reference signal for synchronous detection from the normal colour burst on the back porch.

The ART signal is demodulated as a small but unwanted colour signal, but the subjective effect is small. Since the ART signal is constant over any one scanning line, it produces a small d.c. colour shift after demodulation. Dr. Mayer has demonstrated the possibility of removing the effects of the ART signal from an N.T.S.C. receiver by clamping the colour signals before they are applied to the shadow mask tube. A further suggestion from Dr. Mayer is that a line-by-line switch might be added to the N.T.S.C. receiver to feed a small cancelling signal from the receiver's reference oscillator to compensate for the ART signal.

Such a receiver does not need an N.T.S.C. reference generator, since it derives the reference signal for the synchronous demodulators from the ART signal. The incoming chrominance signal is separated from the luminance signal and is then fed into a delay line. The delayed signal, as in a PAL de luxe receiver, is both added to, and subtracted from, the undelayed signal. If the picture content has not changed, then the N.T.S.C. chrominance signal is the same on successive lines except for the phase reversal of the subcarrier with respect to line sync pulses. Only the ART reference signal, therefore, comes out of the adder, since it has the same phase on successive lines with respect to the line sync pulses, although its phase with respect to the N.T.S.C. zero reference phase is alternating +I, −I, +I, −I. This reference signal is now amplified and limited and a line-by-line switch reverses the polarity of the reference on every line so that a continuous stream of signals, all in the same phase, is fed to the synchronous demodulators.

Suitably phase-shifted versions of this steady reference frequency can now be used for decoding the chrominance signal. The chrominance signal used is that coming out of the subtractor at the delay line; it is quite free of ART signal, which has been cancelled out by the subtraction.

Whenever the picture content changes between one scanning line and the next, then the cancellation processes used in the decoder cannot operate correctly. Dr. Mayer reports that these errors are not disturbing in general, although they become worse as the saturation of the adjacent colours increases. Cross-talk of the high frequency components of the luminance signal can occur, as in N.T.S.C. and PAL, and is principally observed as a flickering at vertical colour transitions such as occur in the colour bar signal. Also, if there are differences in response between the delay and direct channels, then cancellation of the signals is not perfect and a half-line-frequency structure becomes visible at the vertical colour transitions of colour bars, but is not normally noticeable on pictures. G. B. T.

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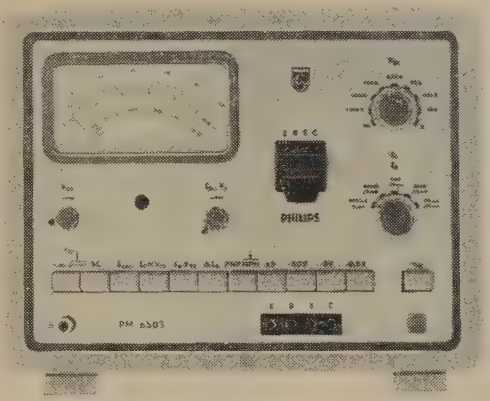

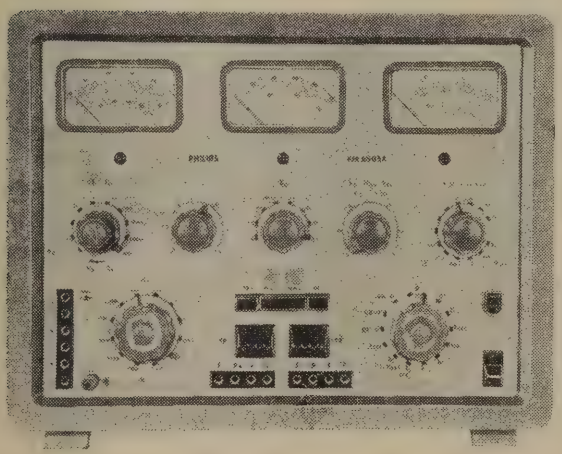

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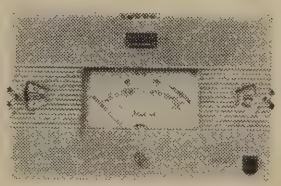

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A Code in the Head

SOME THOUGHTS ON CLASS B PROVOKED BY TALK OF MODULATED PULSE A.F. AMPLIFIERS

By THOMAS RODDAM

THE publication of Mr. Birt's article on modulated pulse amplifiers (*W.W.* Feb. 1963) seems to have stirred up a good deal of life in both the U.K. and the U.S.A. Over cups of tea and cups of coffee voices can be heard saying: "Isn't that just what I was telling you?" Moral number one of Mr. Birt's article is certainly: shut up and build it. Moral number two is that we must, from time to time, try to get a different perspective on the things we think we know. A good time for doing this is when you are on holiday. This ageing writer, having spent the day laboriously raising himself some 3,000 feet above his starting point and then returning with hesitating feet, finds himself daily with a gap of an hour between the putting on of civilized clothing and the earliest decent moment for the first glass of native liquor. One can read Gibbon or Dostoyevsky, or one can think about the fundamentals of one's trade without being bogged down in the details of a particular brass box.

Somewhere or another (for the six books to hand contain no useful references and one, a novel by a friend, isn't even worth reading) William James classifies temperaments as tough or tender. In other words, some people like to classify their ideas in what they regard as systematic groups, while others prefer to generalize. This appears to be a tremendously important matter. New ideas are usually related in some way to what we already know and are produced most easily by taking the most general view we can of our problem; text-book writers and instructors tend towards classification, towards the numbered paragraph or the topic of the day. Resist the temptation to lock all you know into a multiplicity of separate boxes.

Everybody knows that in designating audio-frequency amplifiers the first choice is the choice of device, the second choice is a decision to use class A, class AB, class B operation, or one of the trick models which need not be further defined at this stage. If you look in the text books you will find each of these discussed separately and once you choose your mode you have set foot on a closely walked path. When we are carrying out the detailed design work we do need the detailed analysis of the particular mode. When we first start to think about the amplifier, however, there is some advantage in a rather different point of view. In one case, at least, the general viewpoint suggested in this article will actually clarify the design problems. In others, you must judge for yourself.

Commonsense suggests that undistorted amplification can only be produced by a device with a linear transfer coefficient. If we restrict ourselves to the use of one valve or one transistor we might expect that this would limit us to class-A operation, with the possibility, to be explored, of using some kind of pulse circuit. The limitation, in fact, applies in the simple sense to only one kind of signal, a signal of variable frequency but constant amplitude.

The important thing to remember in dealing with any problem is that we should not ignore any information which we possess. We may, by choice, leave some information out of our detailed study but in doing so we must remember what we have done. In most of our circuit analysis there comes a point when we say: let us approximate. We must not forget that inside the bundle marked "approximately" we have some information concealed.

Coding the Signal

When we wish to process, that is to amplify or transmit, a signal we may make substantial economics if we separate out the information contained in the signal into two groups. One of these groups is the information on the kind of signal with which we are dealing and this information may be handled independently, by a separate channel if necessary, although this separate channel may be multiplexed into the same path as the other group. This concept of coding the signal, and of transmitting the code independently is usually applied to the techniques of rearranging the bandwidth occupied by a signal. The most important application is the use of various codes, like frequency modulation and the pulse modulation systems, to provide an improvement in signal-to-noise ratio. Part of the signal which you hear from an f.m. receiver is, formally speaking, transmitted by letter post as a leaflet giving the details of the deviation and pre-emphasis characteristic.

There is no reason why we should limit ourselves

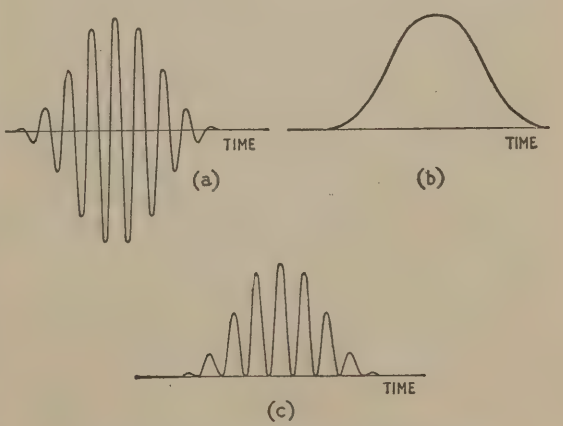


Fig. 1. A syllable of speech and its components.

to coding in terms of frequency. We know, indeed, that we can quantize the instantaneous amplitudes and code these, to give, in one system of transmission, pulse code modulation. We can, and indeed we do, adopt simpler methods of coding. As a first example let us limit ourselves to the amplification of speech. We can say that the signal with which we are concerned consists of frequencies above 200 c/s, modulated by the syllabic frequencies of up to 10 c/s and down to a fraction of 1 c/s. In the gap between these rather arbitrarily chosen figures, 10 c/s and 200 c/s, the speech energy may be neglected. Normally we use only part of this information; we ignore the fact that we have the very low frequency modulation except when we are studying problems of loading in multichannel systems.

Amplifiers using the sliding bias principle make use of more of our knowledge of the characteristics of speech. We can say that a very primitive speech syllable will have a waveform something like that shown as Fig 1(a). Notice that the syllabic frequency appears only as modulation of the audio frequency, so that the lowest frequency will be the sideband term ($f_{\text{audio}} - f_{\text{syllabic}}$). We can extract the syllabic frequency term by rectifying the speech waveform and passing the rectified signal through a

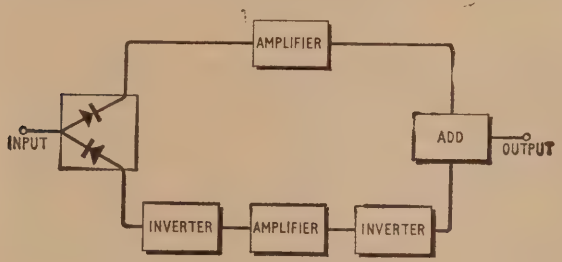


Fig. 2. Principle of coding and decoding.

low-pass filter which has a pass band extending above 10 c/s and gives high attenuation to frequencies of 200 c/s and above. Such a syllabic signal is shown as Fig. 1(b). If we now add this to the original signal, we obtain, provided suitable precautions are taken, the waveform shown in Fig. 1(c). We can always recover the original speech signal, by extracting it with a simple high-pass filter. No part of the added signal (Fig. 1(b)) falls in the audio band and we have not carried out any multiplication operation to cause cross-modulation.

To the extent that Fig. 1(c) represents the waveform which we can produce, we see that it can be amplified by a device which, in its quiescent state, is held just at cut-off and has a linear characteristic through the conduction range. In a practical amplifier we know that we have the cut-off rounding to avoid, and we cannot rely on maintaining the absolute fit of rectified syllabic waveform and speech envelope. Even so, surprisingly high efficiencies combined with high-quality (that is to say high-intelligibility) speech can be obtained.

Putting aside the actual circuit technique, which is usually a reflex system and thus confuses the issue, we see that at the input of the amplifier we code the signal by adding something to it and then decode the signal at the output by filtering out the additive. The coding rules are very simple and are described by Fig. 1.

Let us now consider quite a different position. We shall assume that we know roughly both the frequency and the amplitude of the signal we wish to amplify. This information is of a once-for-all kind, and thus can be built into the code system. Here we have the common problem of the amplifier which follows a master oscillator. The practical solution is to pre-distort the waveform into a pulse of convenient duration and to filter out only the fundamental at the output. The master oscillator provides the information about the exact frequency, somewhere within the allotted range, a range which is defined by the tuned circuits. Here, indeed, we have the familiar class-C amplifier, a highly degenerate case of our more more general problem.

When the frequency is known roughly but the amplitude can vary over a wide range we may still adopt this kind of approach, but the importance which is attached to depth of modulation leads to the use of the rather special case of 180° conduction, the class-B amplifier. The class-B principle is not sacrosanct, for the Doherty amplifier circuit makes use of what we may describe as a topping-up class-C amplifier. It will be interesting to see whether, when really high-power transistors are available, there is a new surge forward in circuit design: valve circuit designers seem to have lost the urge to hunt for the extra few per cent of efficiency and instead of worrying about the extra shillings on the power bill are now trying to save pounds on operators' wages.

Speech and Music

These excursions away from our topic of audio-frequency amplification were not without intent. In the long run we are concerned with signals which have not the simple limitation of high-frequency working. Those readers who have tried to progress from speech compression to music compression will know that in music we have not even got a gap between the syllabic frequency, if we may call it that, and the lowest fundamental frequency which we wish to handle. Compression, a coding system used to improve signal-to-noise ratio, cannot be used for really high quality music. (By compression, of course, I imply subsequent expansion, the overall compansion of the signal).

About the only characteristic of the musical waveform which we can regard as safely to be taken for granted is the fact that it is roughly symmetrical. Let us take this symmetry into account and code the signal by splitting it into two portions, each of which will be handled separately. The only terminology which seems to have been evolved is that used some twenty years ago by tank designers, who may still be using it. They differentiated between the swing and the swang of an oscillatory motion. With a sinusoidal waveform the swing and swang are just the alternate half-cycles, while with a more complicated waveform we may take the swing as all excursions above the axis, and the swang as all excursions below the axis. We know that a pair of rectifiers will then split the audio frequency signal into the two channels, the swing channel and the swang channel. Since the waveform is roughly symmetrical the amounts of signal in the two channels will be about the same. We need to state this formally, because there are ways of splitting the signal up which do not give equal amounts of power in the variable channels. One such system is, indeed,

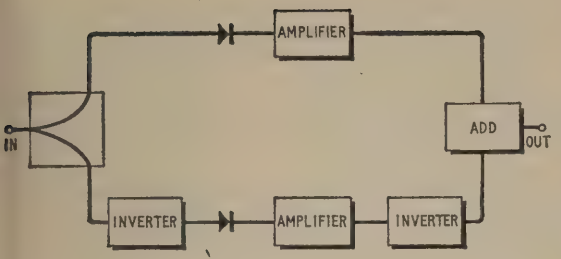


Fig. 3. An alternative input circuit.

the cross-over network used to direct the various parts of the signal to the approximate loudspeakers in a multi-speaker assembly.

Having coded the signal into two channels, they may now be amplified separately. The swang channel may be inverted by either a valve/transistor or a transformer and the swing and swang amplifiers are thus identical. Decoding consists merely of re-inverting the swang channel and adding the two signals together. The overall system is shown as a block diagram in Fig. 2. An alternative construction is to place the inverter in the swang channel before the rectifier, which must then be reversed, giving arrangement of Fig. 3.

The characteristic feature of the two part-signals which we have produced in this operation is that they are unidirectional. A second characteristic feature which must not be overlooked is that in the coding operation we have produced the syllabic frequencies as themselves and not merely as modulation. Unidirectional signals can, of course, be amplified by linear amplifiers working up from the cut-off position, which we know leads to efficient operation with a programme type of signal. The idealized amplifiers, in fact, draw no power at all during quiescent periods. In spite of the apparent complexity of the arrangement we may find it profitable to adopt it. We find that we cannot use the system in the simple form of either Fig. 2 or Fig. 3, because our amplifiers are not linear right down to the cut-off condition. Some sort of compensation for this can be provided by adopting a compromise with a variant of this scheme. In this variant the waveform is still split in two, but an instantaneous compression system is used to squeeze the swang progressively while stretching the swing in one channel, the reverse operation being provided by the other channel. The quasi-rectification again extracts the syllabic frequencies.

When we examine the arrangement of Fig. 3 with the syllabic frequencies in mind we see that the inversion and addition at the output give us a balancing elimination of these frequencies in the output path. This is, of course, vital to the successful operation of a system of this kind for the amplification of music, since we cannot rely on any frequency separation to allow us to filter out the syllabic component. Here there are two points to discuss, one of which leads on to a rather unexpected conclusion, so that I feel I must interrupt the general discussion.

Some, many, most, or even all readers will have seen that the so-called coding system we have just been discussing is, in fact, the common class-B push-pull amplifier. Years ago I should have written stage, but with the advent of the transistor we have seen the use of two or three transistors in tandem on each side and there is a limit to the meaning we can give to "stage". The rectification, of course, takes place at the input electrode, and the inverter is simply one aspect of the phase splitter. The output inverter is the result of the common bridge connection, in one form or another.

In describing this common amplifier in a roundabout way we have stressed the internal production of the syllabic frequencies. It is well known in amplifier design that, *ceteris paribus*, things never are equal. We really cannot rely on balancing out the syllabic frequencies perfectly. Of course, in this day and age, to use one of the most idiotic phrases which ever limped off every tongue, our amplifiers will always be provided with a good deal of negative feedback.

The conclusion is so important that a new paragraph is appropriate. When we use a class-B stage, and this term embraces all push-pull non-linear pairs, the negative feedback loop round the class-B portion must transmit the syllabic frequencies. If we represent the complete amplifier by the diagram in Fig. 4 we must get the syllabic terms which appear at the point O back through the feedback path and the class-A section to the point P. Unless we do this the output will, or at least may, contain terms which we might call interdemodulation terms. Whether, in fact, terms of this kind are objectionable in practice is something which can only be found by a study with a listening panel.

Fluctuating Supply Current

The other point which must be considered in connection with the syllabic component is that in the two amplifiers it is in phase. There is no balancing towards a common supply. We must, therefore, maintain a low supply impedance down to the lowest syllabic frequency. In Mr. Birt's article, which started me off on this track, he lists fluctuation of supply current among the disadvantages of class-B working. However, class-B operation is just one of the ways in which we can code our signal to increase our efficiency or to derive some other advantage. If the coding is used to increase the efficiency we cannot avoid this fluctuation in supply current, as Mr. Birt points out when he considers adding a low-pass filter to his output path. He considers making use of the fact that the waste energy in his system is mainly available as a high-frequency signal, and can be diverted to a resistor by a high-pass, low-pass pair. It is usually convenient to use a resistor rather than a transistor for dissipating the heat.

In practice some class-B amplifiers use regulated power supplies and it is tempting to consider a chopper transistor for regulation purposes. I do not propose to go into this aspect of design here.

A feature of signal coding which appears in the

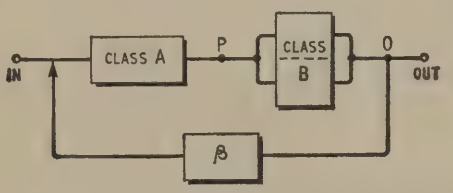


Fig. 4. Complete amplifier with class B and feedback.

systems already mentioned, and in Dome's circuit, which I have mentioned elsewhere and do not propose to discuss, is that all of them appear to involve the introduction of frequencies outside the original signal band. The resulting increase in frequency range which must be considered is the price we pay for increased efficiency. All circuits, indeed, work to the maxim: Hear all, see all, say nowt, and if tha does owt for nowt, do it for thi'sen. A class-A stage, in a silent period, certainly will tak all, gi' nowt.

The object of this approach, this idea that the only way to avoid class-A working is to code the signal, is essentially to change the reader's outlook. In designing an amplifier you may either use class-A stages throughout, or you may adopt a coding system. If you decide to use a coding system, then you may make a choice of an amplitude code or a time code, or even the Dome time-amplitude system. Each system can be considered on its merits, divorced from the old-reliable attitude towards class-B and the new-fangled view of pulse modulation. Be prejudiced, by all means, but at least admit it.

COMMERCIAL LITERATURE

The Series 700 miniature **push-button** switch is described in A.B. Metal Products technical bulletin No. 302. Copies of this 10-page bulletin are obtainable from A.B. Metal Products Ltd., North West House, 119-127 Marylebone Road, London, N.W.1.

9WW 526 for further details

A new brochure giving details of the facsimile method of **transmitting and recording weather charts** is available from Muirhead & Co. Ltd., Beckenham, Kent. Specifications of the current range of Mufax facsimile equipment are included.

9WW 527 for further details

A brochure describing the **activities of the Rank Organisation,** of 38 South Street, London, W.1, in the industrial field, has been sent to us. Thinking ahead in colour (*television*), making it safer to fly, predicting thunder and lightning, communications and control, and applying electronics to surgery are among the sub-titles of this publication.

9WW 528 for further details

A 176-page catalogue listing the products of the Canadian organization Cambridge Thermionic Corporation (Cambion) has been forwarded to us. It lists **equipment fittings and electronic components** and is available from Cambion Electronic Products Ltd., Cambion Works, Castleton, nr. Sheffield.

9WW 529 for further details

A general leaflet, in English, and a technical leaflet, in Swedish, describing a **transistor portable television receiver,** has been sent to us by Luxor Industri Aktiebolag, of Motala, Sweden. A full circuit diagram appears in the technical leaflet.

9WW 530 for further details

A **10-watt servo amplifier,** for use in 50, 60 or 400 c/s systems, is described in Evershed and Vignols leaflet No. 1/353. This leaflet is the first of a series covering the whole range of Evershed servo amplifiers and is obtainable from the Company's works in Acton Lane, Chiswick, London, W.4.

9WW 531 for further details

Telettra S.p.A., of Carlo Poma, Milan, have produced a 23-page English edition of their general catalogue. It contains information on their multiplex telephone, microwave and data transmission systems, and their telecommunications, measuring and power supply equipment.

9WW 532 for further details

Trinistor silicon controlled recifiers, with forward current ratings of 4.7A (mean) and peak repetitive reverse voltages ranging from 30 to 480V are described in the Westinghouse technical publication No. 36-12. Larger s.c.rs, rated up to 70A (mean) with peak reverse and forward voltage ratings of 600 volts, are described in publication No. 36-16. Copies are available from Westinghouse Brake & Signal Company Ltd., 82 York Way, King's Cross, London, N.1.

9WW 533 for further details

Revised literature describing the range of American **Holtzer-Cabot servo, induction and synchronous motors** (Publications M.24 and M.25) is available from Elliott Brothers (London) Ltd., Century Works, Lewisham, London, S.E.13. Electrical and mechanical data is included.

9WW 534 for further details

The 1964 **valve catalogue** is now available from Pinnacle Electronics Ltd., Achilles Street, New Cross, London, S.E.14. More than 1,000 types, from manufacturers all over the world, are listed under subject headings. The types covered range from those used in domestic radio and television to power triodes and tetrodes. A number of specialist types are also included.

9WW 535 for further details

A 12-page catalogue listing the different types **of silicon and germanium semiconductors** manufactured by SESCO (Société européenne des semiconducteurs) has been forwarded to us. This French company is represented in the U.K. by M.C.P. Electronics Ltd., Station Wharf Works, Alperton, Middx.

9WW 536 for further details

A new 36-page brochure giving abridged specifications and performance data for several hundred electrical instruments manufactured by the **Cambridge Instrument Company** is available from the company's head office at 13 Grosvenor Place, London, S.W.1. It describes a number of entirely new instruments, including a 6-dial precision bridge with an accuracy of $\pm 0.005\%$ over the greater part of its range (1Ω to $111M\Omega$) and an a.c./d.c. comparator with an accuracy of $\pm 0.05\%$ between 25 c/s and 10 kc/s.

9WW 537 for further details

A four-page leaflet describing the Siemens & Halske AF 139 Mesa **u.h.f. transistor** is available from the U.K. agents R. H. Cole Electronics Ltd., 26-32 Caxton Street, Westminster, London, S.W.1. A section of the leaflet is devoted to the design considerations of a quarter-wavelength u.h.f. tuner.

9WW 538 for further details

Application notes for cold cathode indicator tubes are contained in a new 24-page booklet (MS/126) from the valve division of Standard Telephones and Cables, Footscray, Sidcup, Kent. Indicator tube applications to digital measuring instruments, computer console displays, frequency counters and telecommunication channel indicators are included. Copies are available from the valve division.

9WW 539 for further details

Literature on the recently introduced Painton-Camblock range of **terminal blocks** is available from Painton & Company Ltd., Kingsthorpe, Northants. In this type of terminal block, the wire is compressed against the busbar with a wedging action by a rotary tapered cam.

9WW 540 for further details

MANUFACTURERS' PRODUCTS

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Silicon Controlled Rectifiers

A NEW series of 8-ampere s.c.r.'s are available from Motorola Semiconductors, New Bond Street, London, W.1. Characterized by being much smaller than existing components of the same current rating, they are designated the MCR1304 series. Voltage ratings are available from 25 to 400V. The s.c.r.'s are housed in a steel case 0.278in long and 0.345in in diameter. Capable of switching up to 3.2 kW, rectifiers of this series can control a full 8A d.c. output. They can operate over a junction temperature range of −40 to +100°C.

9WW 541 for further details

Gas Laser

THE new Raytheon, helium-neon gas laser Type LG-10 uses two plasma discharge tubes optically coupled through a prism to produce a single, high-intensity laser beam directed from one tube into the second parallel one. This enables a high power output, to the order of 100 mW, to be produced from a relatively compact apparatus. Excitation of the plasma tubes is accomplished by direct current. This model is designed for optimum output at 6328 Angstroms but it can produce coherent light at 1·15 or 3·39 microns with minor modifications.

Capable of withstanding shocks equivalent to accelerations of up to 10 *g*, the laser is claimed to have an unusual capacity to tolerate extreme environmental conditions due to the frame and suspension system.

The equipment weighs less than 50 lb and is 57 in long.

9WW 542 for further details

Direct-voltage Regulation

A TRANSISTOR voltage regulator, Type TD428 is available from Newton Brothers, Derby (Newton Derby). The regulator was designed for the precise control of 24 to 28 V generators with field resistances as low as 2·5 Ω. A regulation of ±1 % is achieved. The unit can be used over a temperature range of −20 to +50°C. The response time is claimed to be less than 20 msec. A current-limiting device and a reverse-current protection unit using diodes are available as optional extras. The basic cost of a regulator is £26 18s with reductions for quantity purchasing.

9WW 543 for further details

Axial Hall Probe

THE axial Hall probe constructed from the Scientifica A.9 kit provides the basis from which a number of Hall devices may be constructed. These include an amplifier, oscillator and multiplier. By having the Hall crystal mounted at right angles to the probe axis the probe can be used to measure the magnetic field inside a solenoid or in any position where the magnetic flux is parallel to the direction of the probe. By connecting the output of the probe direct to a 50μA movement meter, field strengths from 50 to 20,000gauss can be easily measured. An indium antimonide crystal is used because of the large output and zero stability associated with this material. The crystal is square in shape, the connections being made to the four corners.

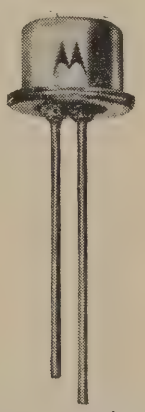
The probe is supplied with a manual which details the constructional procedure and the theoretical principles involved. A standard magnet is provided for calibration and demonstration purposes. The cost of the kit is £19 12s.

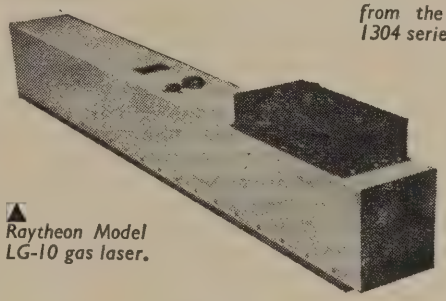
9WW 544 for further details

Instrument Trolley

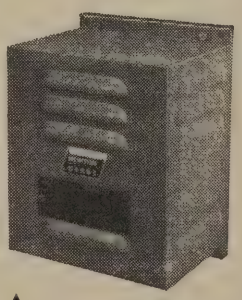
THE main feature of the Type TM10 trolley, manufactured by Avon Communications and Electronics, Christchurch, Hampshire, is that the top tray may be used flat or inclined at any angle up to 20° to the horizontal. Adjustment of the position required is by means of a winding handle. The trolley is constructed

Silicon controlled rectifier from the Motorola MCR 1304 series. ▶



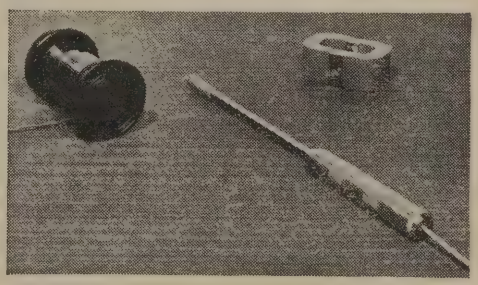


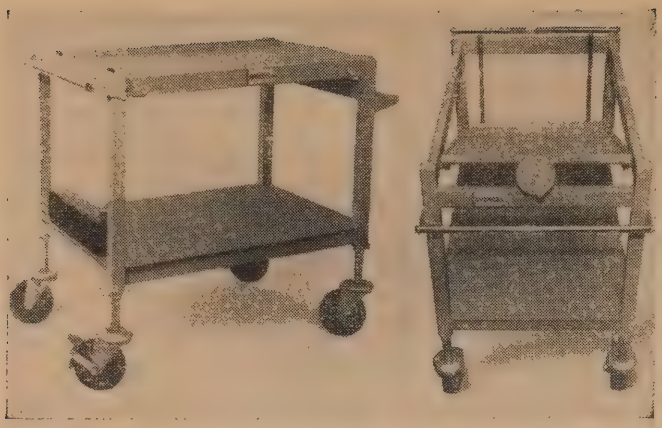
▲ *Raytheon Model LG-10 gas laser.*



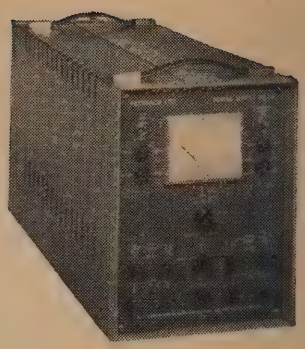
▲ *Transistor voltage regulator for direct-voltage generators manufactured by Newton Brothers.*

Axial Hall probe constructed from "Scientifica" Type A.9 kit. ▼



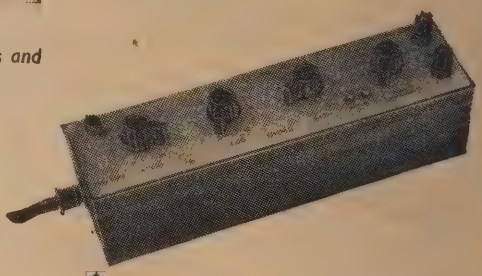


▲ *Instrument trolley Type TM10 manufactured by Avon Communications and Electronics.*



▲ *Feedback power supply Type SD214.*

▲ *Mark II Kilovolter, manufactured by Waveforms.*



▲ *Lionmount Type BW2 Wheatstone bridge.*

from steel tubes welded to form a frame for both shelves. The height of the trolley is adjustable in 1-in steps from 27 to 33 in. The dimensions of the top shelf are $17 \times 28\frac{1}{2}$ in, while those of the lower shelf are 20×30 in. The distance between both shelves is 17 in. Push bars are fitted at both ends of the trolley.

The standard castors fitted are 5-in, heavy-duty, Flexello types with rubber tyres and ball-bearing swivels. Other types can be supplied and these include castors with foot-operated brakes and 5-in, spring-loaded castors with cushion-tyred wheels for transport of delicate instruments, etc. Other accessories that are available include Lexor mains-distribution boards, drawer assembly to fit under bottom shelf and rubber or Formica covers for both shelves.

9WW 545 for further details

General-purpose Power Supply

THE power supply Type SD214 manufactured by Feedback, Crowborough, Sussex, enables the user (by connection alteration) to obtain two separate, "floating" 300 V supplies at 150 mA, a supply of +600 or −600 V at 150 mA and a + or −300 V supply at 300 mA. In addition three 6.3 V outputs are available which can supply up to 16 A. A current-monitoring meter is provided. The total ripple content of the d.c. outputs is less than 3 mV (r.m.s.) and the output impedance is less than 1Ω. The long-term stability of the outputs is greater than 300:1 for variations of up to 15% of the nominal value of the supply. An unusual feature is that the outputs are available either from screw/socket terminals on the front panel or from two, 6-way Painton sockets at the rear. The weight of the power supply is 36 lb and the dimensions are $8.5 \times 12.5 \times 22$ in. The cost of the equipment is £135.

9WW 546 for further details

Kilovolt Measurement

MEASUREMENTS of high voltage over the range 3 to 30 kV can be quickly carried out with the new Kilovolter Mark II manufactured by Waveforms, Vauxhall Bridge Road, London, S.W.1. The instrument is of the calibrated, spark-gap type and is read after withdrawal from the high-voltage source. It does not retain the charge. A $2\frac{1}{2}$ in scale is employed.

9WW 547 for further details

Wheatstone Bridge

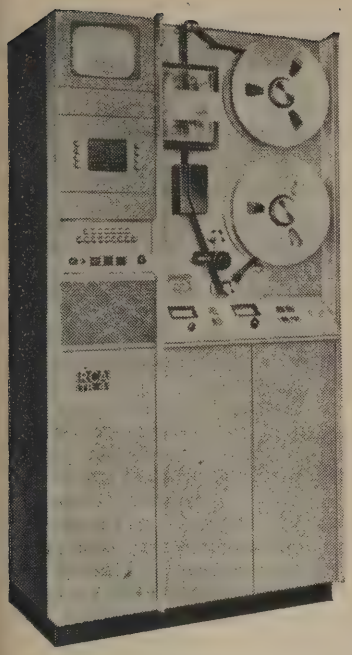
A RANGE of inexpensive Wheatstone bridges is available from Lionmount and Co., Lynton Road, London, N.8. They have been designed for the user who needs to make only occasional resistance measurements and who has access to a sensitive detector. The Type BW2 bridge has a range of 0.1 Ω to 1.11 MΩ achieved with 3 decades and a range multiplier. Other models permit measurements up to 11.11 MΩ. The resistors used are adjusted to 0.1% and are non-inductively wound with a low temperature coefficient wire. The instrument is housed in a mahogany case.

9WW 548 for further details

Photoconductor

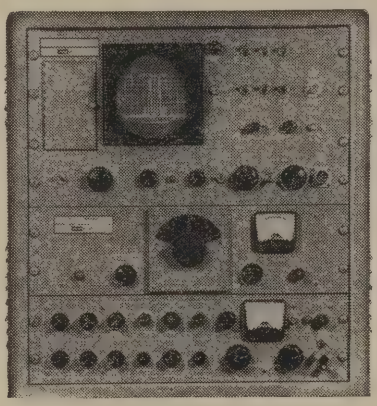
A MINIATURE photoconductor developed by Sylvania and available from Thorn Electronics, Judd Street, London, has a diameter of $\frac{1}{4}$ in and is only $\frac{1}{2}$ in long. The response is claimed to be closely akin to that of the human eye and is ideal for applications ranging from street-lighting control to industrial safety devices. The component can also be used for critical work such as colour matching or flame detection (or failure).

The sensitive area of the cell is restricted to the top of the glass bulb. The field of sensitivity can be effectively screened for precision applications by mounting in a tube. The photoconductor can be used in



TR-4 television tape-recording equipment (R.C.A.).

Instrument air filter (Machine Control.



Panoramic spectrum analyser Type SSB-3b.

ambient temperatures from −40°C to +70°C. Available for a.c. or d.c. use, up to 300 V can be handled.

9WW 549 for further details

Time-delay Units

VARIABLE, electronic, time-delay units are now available from the Electrical Remote Control Company, Harlow. The units are insensitive to temperature variations of −30 to +65°C and mechanical shocks equivalent to accelerations of up to 15*g*. They can operate in any mounting position. Cold cathode tubes are used in the delays which may be set, by potentiometer, to operate in ranges of 0.5 to 5 sec, 2 to 15 sec, 5 to 30 sec and 10 to 60 sec. The reset time is 15 msec. The tube operates only during the actual time-delay period. The size of each unit from this ER series is $4\frac{5}{16} \times 1\frac{27}{32} \times 4\frac{21}{32}$ in. The maximum continuous contact current is 15 A resistive or 5 A inductive.

9WW 550 for further details

Television Tape Equipment

A NEW range of video tape equipment using solid-state techniques has been introduced by R.C.A., Sunbury-on-Thames, Middlesex. The equipments involved at present are the TR-5, a compact, quadruplex recording device with limited playback facilities to permit on-the-spot cueing and preview to check picture quality; the TR-3 playback apparatus which can be easily operated for preview, editing and "on-air" playback, thus freeing existing video tape recorders from replay-only functions; and the TR-4, a complete record-playback unit.

All these equipments are switchable between 405, 525 and 625 line standards and operate on 230 V, 50 c/s. They also have two speeds, 15 and $7\frac{1}{2}$ in/sec (accessory units will be available for colour operation). An important feature of this new range is that they are compatible with other quadruplex recorders.

The TR-4 equipment includes picture and waveform monitors, audio monitor and a full complement of instrumentation for check-out and adjustment purposes. Facilities are provided for plug-in accessories including cue record/playback unit, electronic splicer, automatic timing correctors and air-bearing headwheels.

9WW 551 for further details

Air Filters

NEW air filters which are designed as plug-in units for electronic instrumentation are available from Machine Control, Crawley, Sussex. Standard sizes are available to fit holes of 3, 6, 8, 9, 10 and 12 in diameters. The standard range of filters is only suitable for insertion in material thickness between 16 and 22 s.w.g. The filters have circular, polythene frames which dispense with the need for separate frames on the equipment. The filtering medium, which is inserted at the time of moulding, consists of 2 grades of "de-membraned," synthetic foam. Four standard filters are available giving collecting efficiencies between 48 and 98% on 5-7 micrometre (microns) dust particles. A p.v.c. mesh is used to protect the filter material. The manufacturers claim that the only maintenance necessary is periodic washing with water and detergent. Special sizes and shapes can be produced to customer specifications.

9WW 552 for further details

Spectrum Analyser

THE frequency range of a new spectrum analyser Type SSB-3b manufactured by Panoramic, extends from 2 to 40 Mc/s. The input impedance is 50 Ω but when used with the cathode-follower probe it is 12 MΩ (5 pF). Special features of this instrument include pre-set sweep widths of 150 and 500 c/s and 3.5, 7

INFORMATION SERVICE FOR PROFESSIONAL READERS

To expedite requests for further information on products appearing in the editorial and advertisement pages of *Wireless World* each month, a sheet of reader service cards is included in this issue. The cards will be found between advertisement pages 16/19.

We invite readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by 9WW, and it is then necessary only to enter the number(s) on the card.

Readers will appreciate the advantage of being able to fold out the sheet of cards, enabling them to make entries while studying the editorial and advertisement pages.

Postage is free in the U.K., but cards must be stamped if posted overseas. This service will enable professional readers to obtain the additional information they require quickly and easily.

and 14 kc/s, a 0 to 100 kc/s variable scan, continuously-adjustable two-tone generator and a marker display that checks the residual distortion of the analyser to better than 60 dB. The sensitivity of the equipment is virtually uniform over the complete frequency range. The instrument is marketed in the U.K. by Roberts Electronics, Hitchin, Herts.

9WW 553 for further details

Oscilloscope Cameras

TWO new Fairchild-Du Mont oscilloscope cameras Types 453 and 453A are available from Aveley Electric, South Ockendon, Essex. Photographic records from 4×5 in down to 35 mm can be obtained. The camera shutter is lever actuated and the oscilloscope screen can be viewed during recording. The object-to-image ratio is continuously variable over a range of 1:1 to 1:0.7 with one lens and without the need for extra attachments such as spacers or gauges, etc. Either *f*1.9 or *f*2.8 lenses can be supplied.

9WW 554 for further details

In-line Indicators

NEW digital-indicators are available from Hilger and Watts, St. Pancras Way, London, N.W.1. Designated the Hiray series they can be used in high ambient light conditions and are designed to be powered from supply voltages of 6, 12 or 28 V. The figures, $\frac{3}{4}\times\frac{1}{2}$in, are edgwise lighted and mounted in an insulated case 3×1×1·5 in in size.

Each unit, or decade, comprises a stack of 10 Perspex plates engraved with the numerals 0 to 9 (two extra plates can be added). Each plate is edge illuminated by a midget lamp. Contact with the lamps is via a printed-circuit plate which hinges back to facilitate lamp changes. External contacts are to hollow rivets, each clearly marked to show the numeral connected. The lamp life is expected to be 2000 to 3000 hours at 12V. Components of the Hiray series may be mounted behind or in front of a panel.

9WW 555 for further details

Transmitter-Receiver

OPERATING over the frequency ranges 71 to 101 Mc/s and 156 to 174 Mc/s, the Ultra Electronics f.m. transmitter/receiver Type 4B6 weighs only 3 lb and measures only 8×5×1¼in. The equipment includes a retractable whip aerial but a socket permits connection of an external aerial. The standard equipment contains a combined loudspeaker and microphone (with a press-to-talk switch) but other hand or head sets can be provided. The power output is 500 mW. The equipment is powered by a nickel-cadmium rechargeable battery which permits 8 hours continuous operation on a 10:1 receive/transmit ratio. The operational range is approximately 5 miles. The equipment is G.P.O. type-approved. The address of the manufacturers is Ultra Electronics Ltd., Telecommunications Division, London, W.3.

9WW 556 for further details

Spectrum Analysis

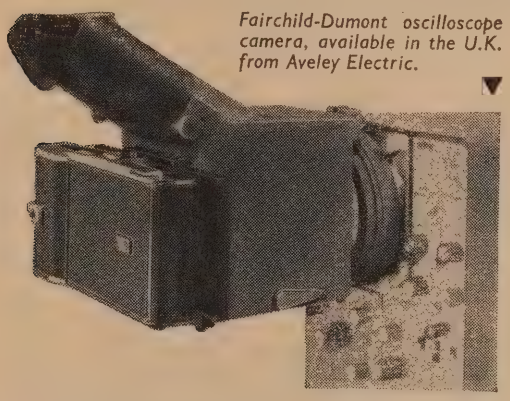
A SERIES of plug-in units is available which, when used with the Tektronix 530/540 series of oscilloscopes, provides spectrum-analysis facilities. Manufactured by Pentrix and available in the U.K. from Livingston Laboratories, Camden Road, London, N.W.1, the available units can be used in h.f., u.h.f. and microwave fields. The Type L20 unit covers the frequency range 10 to 4,000 Mc/s and the sweep width can be varied from 2·5 kc/s to 5 Mc/s on the narrow range and from 100 kc/s to 60 Mc/s on the wide range. The sweep rate is adjustable from 0·02 to 1000 c/s. Fixed and variable markers are provided and the display can be logarithmic, linear or square law. Provision is made for a video input with a response from 10 c/s to 10 Mc/s.

9WW 557 for further details

Screened-room Filters

SCREENED-ROOM filters, manufactured by Aerovox are now available in the U.K. from F. G. Robinson and Partners, Wimbledon, London, S.W.19. These filters, with their simple mounting arrangements, ensure that mains supplies taken into screened rooms are free from inter-

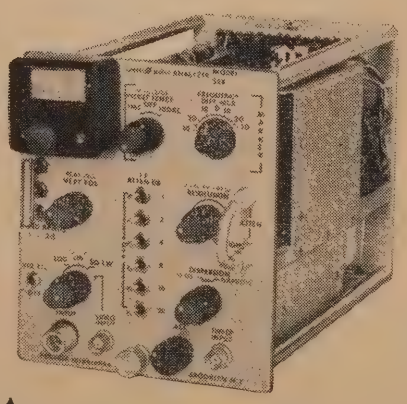
(*Continued on page* 317)



Fairchild-Dumont oscilloscope camera, available in the U.K. from Aveley Electric. ▼

▲ *Digital in-line indicator from the Hilger and Watts "Hiray" series.*

Ultra Electronics Type 4B6 f.m. transmitter receiver. ▼

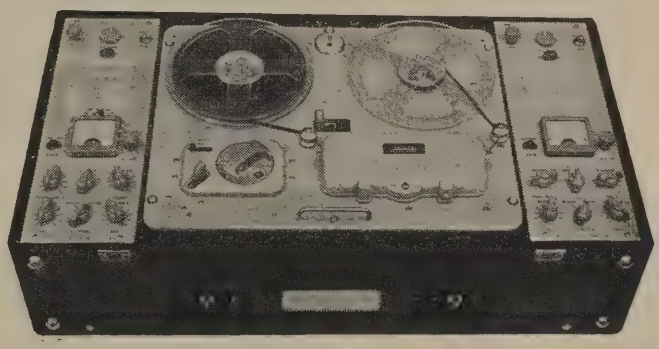


▲ *Plug-in unit Type L20 may be used with Tektronix oscilloscopes to provide spectrum-analysis facilities (manufactured by Pentrix).*

—Vortexion

quality equipment

TYPE C.B.L. TAPE RECORDER



The Vortexion C.B.L. is capable of making and replaying the very highest quality recordings of either monaural or stereo whether " live " or transcript. This instrument however is intended to be more than a straightforward tape recorder in that provision is made not only to mix inputs on each side but also to feed the playback from the other track into the new recording. Each input is separately controllable and measured on the two meters. " Before and After " monitoring is employed and the echo facilities are more extensive than the W.V.B. The track-to-track cross-mixing function may be switched out when not needed as, for instance, listening to cues from one track whilst recording on the other.

The Vortexion W.V.B. is a high quality monaural machine with " Before and After " monitoring. The recording inputs are a high sensitivity socket for moving coil or ribbon microphone and a high impedance socket for radio, etc., either of which can be selected by a switch. Superimposing and echo work can be done and the playback has reserve gain for abnormal requirements. This model cannot be converted for stereo playback, but is a thoroughly reliable machine for the engineer specialising on monaural work.

The Vortexion W.V.A. is a monaural machine which has a performance equal in sound quality to the other models. It possesses all the features of the W.V.B. except for " Before and After " monitoring, Dubbing and Echoes. The recording being made can be heard on the internal loudspeaker as in the W.V.B. and C.B.L. The controls are uncomplicated.
All tape recorders have adjustable bias controls, low impedance mic. inputs for unlimited lengths of cable, highly accurate position indicators and meters to measure recording level and bias.

The Vortexion 30/50 watt Amplifier can deliver 50 watts of speech and music or over 30 watts of continuous sine wave and the main amplifier has a response of 30 to 20,000 cps within 1dB at 0.1% distortion and outputs for 4, 7.5, 15 ohms and 100 volt line. Models are available with two, three or four mixed inputs which may be low impedance balanced line microphones, P.U. or Guitar inputs.

The 120/200 watt Amplifier can deliver its full audio power at any frequency in the range of 30 to 20,000 cps for which the response is accurate within 1 dB with less than 0.2% distortion at 1,000 cps. It can be used to drive mechanical devices, i.e. synchronous capstan or projector motors, etc., for which the power is over 140 watts on continuous sine wave. The input is for 1 m.w. 600 ohms, the output for 100-120 volts or 200-240 volts and additional matching transformers for other impedances are available.

Other items of our manufacture are:

Record and Playback Mixer.
2 x 5-way Stereo Mixers.
12-way Mixers.
4-way Mixers.
Erase Fader Unit for above recorders.
4-way Mixer with 10 watt output and tone controls.
3-way Mixer and Peak Programme Meter.
2-way 30/50 ohm in and out stud-type Mixers.

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, London, S.W.19

Telephone: LIBerty 2814 and 6242-3-4 Telegrams: "Vortexion, Wimble, London"

9WW—112 FOR FURTHER DETAILS.

NAVAL RADIO TRANSMITTING SYSTEMS

■ Precise frequency setting and positive stability allows full advantage to be taken of SSB which provides the most reliable communications under difficult conditions of propagation or interference ■ Continuous frequency coverage from 240 Kc/s to 24 Mc/s ■ Covers all types of signalling ■ Broadband amplifier and synthesizer system provides simplest operation and almost eliminates tuning ■ Aerials can be sited for maximum radiating efficiency.

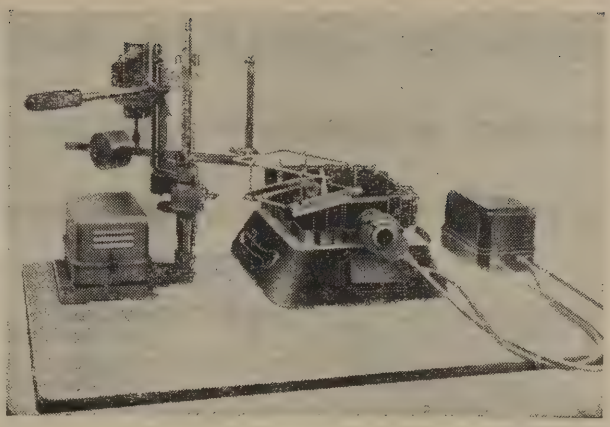
MARCONI NT 203/204 SYSTEMS

COMPLETE NAVAL RADIO AND RADAR SYSTEMS

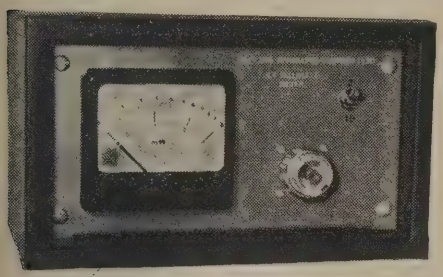
THE MARCONI COMPANY LIMITED · CHELMSFORD ESSEX ENGLAND

9WW—113 FOR FURTHER DETAILS.

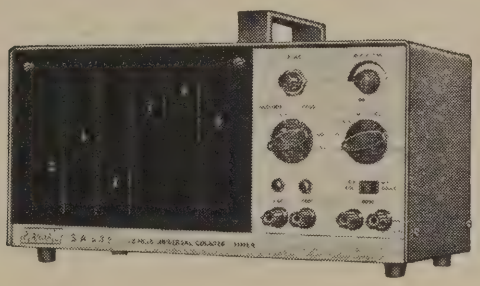
▲ *Solartron digital voltmeter Type LM. 1420.*



▲ *Semi-automatic, dip soldering equipment (Zeva).*



▲ *R.f. power meter manufactured by Electro Apparatus.*



Electronic counter/timer Type GA. 535 manufactured by Racal Instruments. ▶

ference and that signals inside the room are not fed into the mains. Several different current and voltage ratings are available and the frequency band attenuated extends from 14 kc/s to 1,000 Mc/s. (Two special types extend the range to 10,000 Mc/s). In the lower current types (30 and 50 A) single-, two- or three-circuit units are available. The maximum size for a single-circuit version is $4\frac{3}{8}\times4\frac{3}{8}\times22$in. All types are hermetically sealed with shielded terminals.

9WW 558 for further details

Digital Voltmeter

A FOUR digit, display system employing cold-cathode tubes is utilized in the Solartron digital voltmeter Type LM.1420. The six ranges permit full scale readings from 20 mV to 1000 V. Apart from the display tubes transistors are used throughout, but even so, very high input impedances are achieved (greater than 5,000 MΩ on the 2 V range). The inputs are isolated from the chassis. The stability of the power circuitry is such that the instrument can be used with mains supply variations of −20 to +15%. The temperature range over which the instrument works is 0°C to 50°C. The instrument can be obtained in a portable case, the total weight being 25 lb. It can also be supplied as a rack-mounting voltmeter.

9WW 559 for further details

Soldering Machine

A NEW dip-soldering machine is available in the United Kingdom from Avo, Vauxhall Bridge Road, London. Manufactured by Zeva (w. Germany), the equipment consists of a thermostatically-controlled solder bath, which presents a surface area of $9\frac{1}{2}\times11\frac{3}{4}$ sq in and a semi-automatically controlled dipping cradle. The soldering time can be varied over a range of 0 to 10 sec.

9WW 560 for further details

Power Meter

AN R.F. milliwattmeter has been developed by Electro Apparatus, Stansted, Essex, with a v.s.w.r. of better than 1.1 up to a frequency of 1,000 Mc/s. Two versions are available, one enables power to be measured on two, full-scale ranges of 3 or 10 mW and the other has a 25 mW range. This latter version can be extended to 250 mW and 2.5 W by attenuators available as optional accessories. The impedance is 50Ω and the input connector can be fitted on either the rear or front panel. Connectors that can be supplied include EID $\frac{3}{4}$in, G.R., C, B.N.C. or Dezifix types. The overall accuracy of the instrument is 10%. The instrument weighs 10 lb. and the dimensions are $11\times8\times7$ in.

9WW 561 for further details

Electronic Counter

A SOLID-STATE, 1-2Mc/s counter/timer has been added to the Racal (Bracknell, Berks) range of digital counters and frequency meters. Using a 6-digit display the Type SA.535 counter enables direct frequency measurement from z.f. to 1.2Mc/s from signal levels as low as 70mV. The 1Mc/s oven-controlled crystal oscillator permits a measurement accuracy of ±1 count ±1 part in 10^6 over a temperature range of 0 to 45°C. Time measurement from 1μsec to 2.8 hours and multiple-period, average measurements are among the applications of this instrument. An external 1Mc/s standard may be used to increase the accuracy of the equipment. Other facilities include outputs in decade steps from 100c/s to 1Mc/s and an output for a printer. The instrument can be powered from 115/230V, 50c/s supply, 115V, 400c/s supply or from external batteries.

9WW 562 for further details

Bridge Source and Detector

TRANSISTOR SINGLE-FREQUENCY OSCILLATOR AND AMPLIFIER

By F. BUTLER, O.B.E., B.Sc., M.I.E.E., M.I.E.R.E.

A BATTERY-POWERED transistor audio oscillator followed by a Class B power amplifier makes an ideal power source for an impedance bridge. As an output indicator or null detector, a transistor high-gain audio amplifier is equally good and may be used with headphones, a rectifier voltmeter or some type of visual indicator. Both units are compact enough to build into a general-purpose bridge, with negligible increases in overall size and weight. The low capacitance to ground helps to maintain the bridge accuracy at extremes of the measuring range, there is no power-supply hum or noise and no trouble due to multiple earth points as there may be with mains-powered equipment.

In the ordinary way it is necessary to use specially screened transformers to couple the source or detector to the bridge. Where the highest precision is required it will always be necessary to use some screening, but it can be simplified or left out altogether in general-purpose wide-range bridges in which the complex internal switching causes errors large enough to swamp those caused by the small parasitic capacitances introduced by the source and detector.

One point is vitally important; it is that there should be no direct coupling between source and detector except through the bridge impedances. Gross errors are inevitable if spurious coupling exists. In principle it is a simple matter to provide the necessary isolation, but if source and detector are in the same cabinet, and if they use a common power supply, quite elaborate screening, grounding and decoupling measures must be taken to prevent interaction. It is simpler and cheaper to build two physically separate and self-contained units and resist any temptation to combine them.

Some Design Considerations

A typical general-purpose bridge may be called upon to measure resistance between 1 milliohm and 1 megohm, capacitance between 1 pF and 100 μF and inductance between 1 μH and 100 H. Resistors have residual series inductance and shunt capacitance, capacitors have series inductance and an equivalent series or shunt loss resistance, while inductors have distributed capacitance and series loss resistance. In all cases the impedance and phase angle are functions of frequency and no single measurement is sufficient to describe the properties of a circuit element over a wide range of frequencies. Nevertheless, useful information comes from equivalent resistance and reactance measurements made at a single frequency and this is all that the simpler wide-range bridges set out to do. The test frequency is commonly 1 kc/s when telephones are employed as the null detector.

There are, in fact, some advantages which spring from the use of a single frequency. In the first place, a tuned detector-amplifier may be used to reject hum, noise and harmonics of the test frequency, whether present in the driving oscillator output or generated by non-linear elements (like iron-cored coils), in the bridge itself. Secondly, when measuring inductors or capacitors, it is generally required to know something about the losses as well as the nominal inductance or capacitance. The quality factor Q of a coil or capacitor is the ratio of reactance to series resistance at the specified test frequency. The dissipation factor D is the inverse or reciprocal of Q and, for reasonably low-loss components, is almost equal to the power factor. Thus $D=1/Q=R/X=\cos\phi$, where $X=\omega L$ or $1/\omega C$, R is the equivalent series loss resistance and ϕ is the phase angle. It is convenient if the D and Q dials on the bridge can be made direct-reading and this is only possible at a single frequency.

Assuming operation at 1 kc/s, some thought must now be given to the level of input power to the bridge and, related to this, the requisite sensitivity of the null detector. Low input power can be offset by increased detector gain, subject to limitations set by the output signal-to-noise ratio. However, there are more subtle points to be considered. Over the whole of its measuring range the input impedance of the bridge may vary between 100 ohms or less up to as much as 20,000 ohms. Its output impedance, as seen by the detector, may cover a similar range. True impedance matching is inconvenient if not impracticable. A difficulty is that the maximum undistorted power output from an amplifier is only delivered into a specified load resistance. The output is less, and the distortion greater, for an unmatched load, particularly if this is reactive. One solution is to place a dummy load resistance of low value in shunt with the bridge input, and design the amplifier to match the composite load. Though inefficient, this limits the possible range of variation of impedance. It should be backed up by the use of a tuned output stage to reject harmonics and by negative feedback to make the amplifier less sensitive to load changes.

It is well known that the inductance of iron-cored coils depends on the level of the applied voltage. Ideally the test conditions should approximate to those under which the component will be used and this implies that the bridge oscillator output must be variable over a wide range. Microphone and low-level interstage transformers operate with flux densities so low that the effective permeability of the core is small and may be taken as the initial permeability. Small iron-cored coils of low inductance also require low test voltages in order to avoid incipient saturation and consequent waveform dis-

tortion which may be so serious as to make it impossible to balance the bridge.

By contrast, output and power transformers, filter chokes and similar components will show abnormally low inductance if measured under small-signal conditions. One must also allow for the effects of d.c. bias in filter chokes and output transformers, including unbalanced d.c. in push-pull stages. On the whole, it is best to make measurements under low power conditions since the results will then err on the pessimistic side.

Another advantage of low-power operation is that electrolytic capacitors can be safely measured without a polarizing voltage. Finally, it may be remarked that bridge measurements on non-linear components are meaningless unless the test conditions are precisely specified.

Taking everything into consideration, experience shows that a low-distortion 1 kc/s source, capable of maintaining 2 or 3 V r.m.s. across the bridge input terminals, combined with a tuned detector-amplifier giving 60 dB power gain, meets most requirements. This amount of detector gain is easily provided by a 3-stage amplifier. The use of low-impedance headphones (50 ohms d.c. resistance and about 100 mH inductance), simplifies transformer design since the load impedance is around the standard value of 600 ohms. Limitation of the output power from the detector-amplifier is of advantage since it prevents the operator from being deafened by the signal from a grossly unbalanced bridge.

Transistor Oscillator-Amplifier

To construct and adjust the practical equipment to be described in the rest of this paper calls for a certain amount of test equipment. This should include a calibrated audio oscillator, a simple impedance bridge and an oscilloscope as well as a multirange meter. So far as possible, standard components have been incorporated, but a few items need to be specially made.

The bridge oscillator-amplifier circuit is shown in Fig. 1. The oscillator itself, built around the transistor Q1 has an unfamiliar look but is basically of the earthed-base configuration. The tuning inductance L_1 (125 mH) resonates at 1000 c/s with the series combination of C_1 and C_2 (0.25 and 1μF respectively). Emitter drive is taken from the junction of C_1 and C_2. The inductance L_2 (also 125 mH) acts as an a.f. choke but, because of its low value, effectively modifies the capacitance of C_2 across which it is shunted. Both L_1 and L_2 consist of a few hundred turns of wire wound on small nickel-iron E I laminations, core section $\frac{1}{4}$in.$\times\frac{1}{4}$in. The inductance is trimmed to the desired value by adjustment of the airgap. Alternatively C_1 and C_2 may be selected to give the correct operating frequency, which should lie between 990 and 1010 c/s.

Both these methods of adjusting the frequency are tedious and time-consuming. A simpler way is to choose the main components so that the frequency is rather higher than 1 kc/s and then reduce it by a small capacitor (0.005μF is used in Fig. 1), connected between collector and base of the oscillator transistor. Miller feedback increases the effective value of this capacitor by a factor almost equal to the voltage gain. Quite small capacitances will cause a substantial drop in frequency. The method should be used with caution because of the dependence of capacitance (and oscillator frequency), on voltage gain. The gain is a function of emitter current and this current will fall drastically as the supply battery nears the end of its working life.

Three resistors in the base circuit set the forward bias of Q1. Of these, R_1 (10-33 kΩ), ensures a constant-current base drive and limits the oscillation amplitude so that the output waveform is undistorted. The precise value is best established by trial, being set to give the maximum possible output without waveform clipping. Drive to the next stage is taken from the emitter of Q1 through blocking capacitors and a gain-control potentiometer R_3. An additional series resistance R_2 ensures that the output stage is not overdriven when the gain control is fully advanced. With a 6V battery, the collector currents of Q1 and Q2 are each about 0.75 mA.

A small driver transformer (REPANCO Type TT 21, ratio 4:1+1), couples Q2 to the push-pull Class B output stage. Local series feedback is by means of

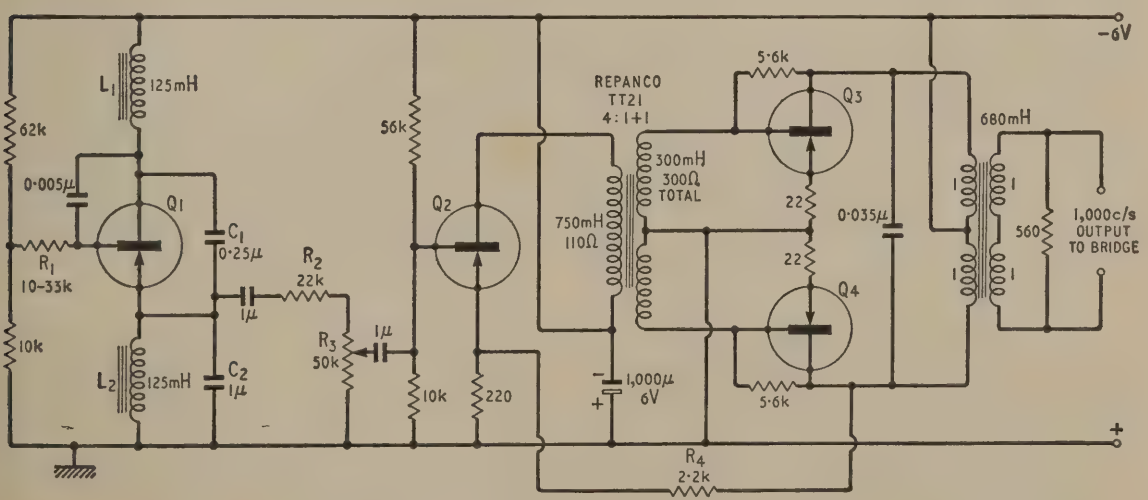


Fig. 1. Practical circuit of 1kc/s oscillator-amplifier.

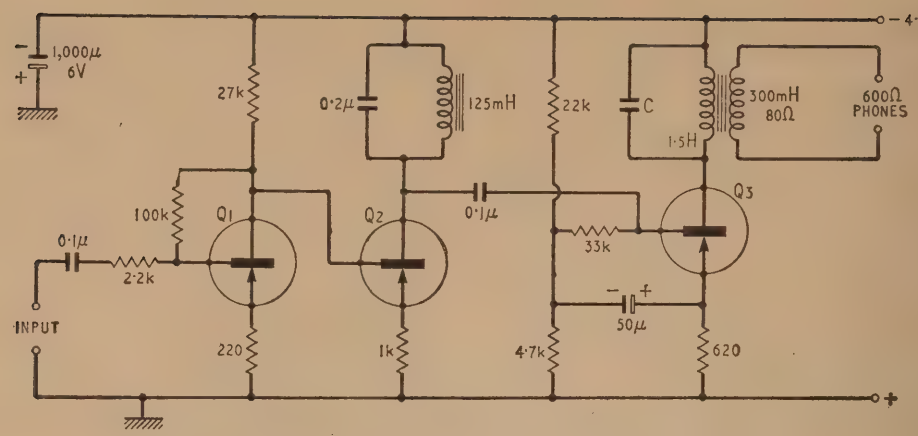


Fig. 2. Tuned detector-amplifier. C is selected to tune output stage to 1 kc/s.

22Ω unbypassed emitter resistances, with shunt feedback through 5.6 kΩ collector-base resistances which serve also to set the quiescent current (5 mA total) for the output stage. This is just sufficient to avoid crossover distortion under low drive conditions. At full drive the collector current rises to 40 mA from a 6 V supply.

Overall negative feedback is taken from one side of the output transformer through 2.2 kΩ to the emitter of Q2. The feedback voltage is developed across a 220 ohm resistor. If self-oscillation occurs, the feedback is positive. To suppress this, R_1 should be changed over to the opposite end of the transformer winding.

To compensate for the wide variations of input impedance of the bridge, the secondary of the transformer is loaded by 560 Ω. Even so there is some waveform distortion. This may be cured by shunting a suitable capacitor across the primary winding to make it resonant at 1 kc/s.

Although the input power to the bridge need be no more than a few milliwatts, the output transformer should be conservatively designed and a 500 mW size is not unreasonable, since it is the key component in the whole equipment.

The overall turns ratio should be about 1:1, the primary being centre-tapped for push-pull working. Winding resistances each up to 10 ohms are permissible. The winding capacitances to ground should be small and, more important, they should be symmetrically distributed. Ideally the windings should be individually screened and a third shield should be used between primary and secondary. In practice, for use with a general purpose bridge, it is sufficient to use symmetrical windings with a single inter-winding screen of copper foil, earthed to the metal panel of the bridge or to the bridge earth point.

Assuming a core cross-section about $\frac{5}{8}$in.×$\frac{5}{8}$in., the best method of construction is to make up two former-wound coils as the half-primary windings (500 turns each, 36 s.w.g. enamelled copper), assembled side-by-side on the core. Two similar coils, large enough to slip over the primary, should constitute the secondary, space being left between the pairs for a primary-to-secondary shield. True symmetry can be guaranteed by winding one of each pair in the opposite sense of rotation to the other. The inner, starting ends of both half-primary windings can be joined together and used as the h.t. centre-tap, the outers being joined to the transistor collectors. The two half-secondaries are similarly joined but the centre tap is unused. If this drill is correctly carried out, the two sets of half-windings will be connected series-aiding and with perfect symmetry. The construction does not minimize the leakage inductance but this consideration is not so important as it would be in a wide-band audio output transformer.

Finally, the transformer should be fitted into a heavy-gauge drawn steel case or, better, in a mu-metal screening box. These are available at low cost on the surplus market.

If this method of construction is felt to be overlaborious, an easier alternative, with little degradation of performance, is to bifilar-wind both primary and secondary coils. It is still worth while to use an inter-winding screen, taking care to leave a gap or an insulated overlap to that the foil does not behave like a short-circuited turn. One test of a successful design is that reversal of the transformer connections to the bridge should cause no change in the balance setting.

The output transformer shown in Fig. 1 has a total primary inductance of 680 mH, with a d.c. resistance of 8 ohms. The secondary characteristics are almost identical.

Tuned Detector-Amplifier

This unit is shown in Fig. 2. Here Q1 is a simple RC amplifier with shunt and series feedback. It is direct-coupled to the tuned amplifier Q2 in which local series feedback gives a high output impedance with low damping of the associated tuned circuit. The output stage Q3 is boot-strapped to give high gain. The resulting high input impedance assists in preserving good selectivity.

The output transformer is a miniature driver transformer with an overall step-down ratio of about 2:1 for matching low impedance telephones (50 Ω d.c. resistance; impedance 600 Ω at 1 kc/s). High winding resistances cause a relatively large insertion loss but the overall voltage gain is still in excess of 200, the power gain to a 600 Ω resistive load being about 56 dB.

Traces of distortion may be removed by tuning the output stage to 1 kc/s by means of a shunt capacitor. Selectivity is so high that it is essential

to adjust both oscillator and amplifier to the same frequency, even if this is not exactly 1 kc/s.

Connection of the Bridge

One, and only one, of the four corners of an impedance bridge may be earthed directly. In some bridges this point is actually connected to the metal panel or cabinet of the instrument. In other cases the bridge is electrically isolated from the metalwork. The question of how and where to put grounds on the ancillary equipment thus becomes important. Some designers prefer to earth one side of the detector. This is good practice when head telephones are used since their capacitance to ground is less liable to cause errors than if neither side were earthed.

The difficulties are thus transferred to the oscillator side of the bridge. The use of a symmetrically-wound supply transformer with separate winding screens and an inter-winding shield has the effect of substituting known, small and equal capacitances for the large, unequal and indefinite capacitances which would otherwise lead to large measurement errors. One can be driven to desperation while tracking and correcting minute sources of error caused by parasitic capacitances and spurious couplings in precision bridges but, when 1 per cent accuracy is the target figure, some precautions can be relaxed.

Normally it is sufficient to connect one side of the oscillator supply battery (and hence one bus-bar of the circuit), to the metal case. The earth connection shown in Fig. 1 is made to the aluminium cabinet at a single point. It is desirable, but not always essential, to make another connection from the box to a true earth such as a copper main water pipe.

The null detector-amplifier wiring may be grounded at one point to its metal chassis or may be left isolated. In either case the cabinet itself should be connected by a single wire to the oscillator chassis. The inter-winding shield of the output transformer should be connected to the earth point of the bridge network.

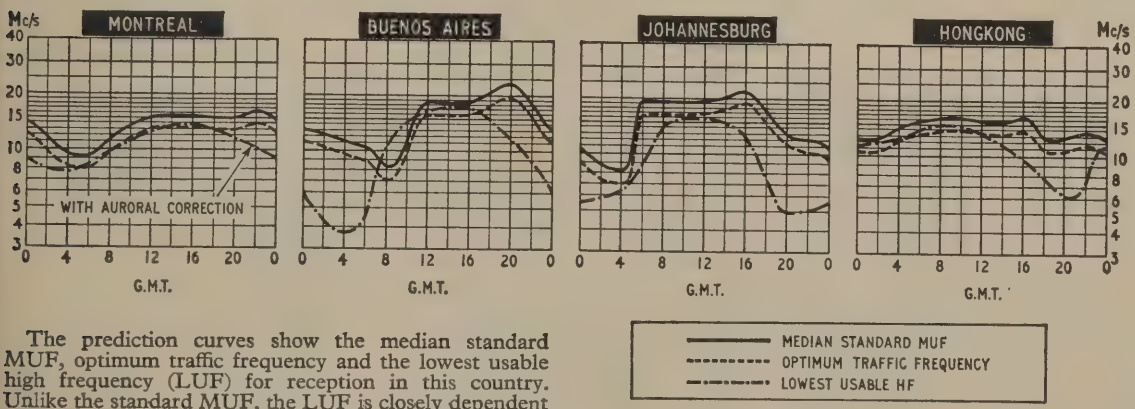
Finally, some checks should be made to establish confidence in the complete assembly. With the oscillator switched on, close to, but disconnected from, the bridge there should be no output from the null detector at any setting of the oscillator gain control. Telephones are in fact so very sensitive that a faint residual sound is almost certain to be heard but its level should be comparable with the circuit noise.

With the bridge in use to check a variety of components, the balance settings should remain constant when the leads from the output transformer to the bridge are changed over. Moreover, the balance setting should not change as a result of varying the oscillator output power by means of the gain control (except when tesung iron-cored coils or non-linear components).

Even when stray capacitance effects are small enough to cause negligible errors in the measurement of inductance or capacitance, there may be serious inaccuracies in the dissipation factor indications or Q measurements. With most wide-range bridges these latter measurements are rather crude and are unlikely to be worsened by the use of transistorized ancillaries.

The two units described were constructed for use with a General Radio Impedance Bridge, Type 650-A. This normally uses a built-in microphone hummer as an a.c. source, with high-impedance headphones as the null detector. Its specified accuracy is unaffected by substituting the transistor oscillator and null detector, while the sensitivity and discrimination have been much improved. Control of the oscillator power output is particularly useful when measuring low-inductance iron-cored coils, small ferrite toroids and high-capacitance low-voltage electrolytic capacitors.

H. F. PREDICTIONS — JUNE



The prediction curves show the median standard MUF, optimum traffic frequency and the lowest usable high frequency (LUF) for reception in this country. Unlike the standard MUF, the LUF is closely dependent upon such factors as transmitter power, aerials, local noise level and the type of modulation: it should generally be regarded with more diffidence than the MUF. The LUF curves shown are those drawn by Cable and Wireless, Ltd., for commercial telegraphy and they serve to give some idea of the period of the day during which communication can be expected.

During the summer months in the minimum of the solar cycle past experience has shown that frequencies considerably higher than the predicted standard MUF can at times be received. This effect is mainly confined to daytime on the radio path and has been especially noted on reception in the U.K. from the Far East. The cause is thought to be associated with sporadic-E ionization.

NEWS FROM INDUSTRY

£18.9M Semiconductor Sales.— According to figures from the British Radio Valve Manufacturers' Association (BVA) and the Electronic Valve and Semiconductor Manufacturers' Association (VASCA), British valve, c.r. tube and semiconductor sales totalled £61.6M last year. This figure, which is the first ever to be released for total sales, includes total exports of £11.2M.

The present **telephone system in South Africa** is to be augmented by a large S.T.C. microwave radio-telephone network. Orders worth more than £500,000 have just been received through S.T.C.'s South African subsidiary company for microwave equipment for routes between Bloemfontein, Port Elizabeth, Cape Town and East London. And equipment already on order for the 366-mile Johannesburg-Durban link, soon to be installed, brings the total of recent S.T.C. microwave orders from South Africa to well over £1M. The 6 Gc/s equipment will be manufactured at S.T.C.'s North Woolwich plant near London, and a high proportion of wave-guide components and similar items will be manufactured at S.T.C.'s new Scottish plant at East Kilbride.

25-Year Liberian TV Contract.— Rediffusion has signed a twenty-five-year agreement with the Government of Liberia to manage and operate the commercial radio and television services in that country. A new company, Rediffusion (Liberia) Ltd., has been formed for this purpose, and it will also trade in sound radio and television receivers. The country's first commercial television station in Monrovia, the capital, began broadcasting in January this year (see February issue, p. 82).

"Condor I", the Italian hydrofoil being used by Condor Ltd. of Guernsey for regular services between the Channel Islands and the northern French coast, is fitted with a Decca D202 radar. Her radio equipment comprises a Marconi Fulmar transmitter and Guardian receiver.

A new company, **General Precision Decca Systems Incorporated,** has been formed jointly by the Decca Navigator Company and the General Precision Equipment Corporation of New York, to manufacture and market Decca equipment in the United States. Products will include hyperbolic navigation systems, position fixing systems for survey, airborne computers, and pictorial displays.

A.P.T. Electronic Industries Ltd. have acquired a majority interest in **Cybernetic Developments Ltd.** It will operate under the same name from Chertsey Road, Byfleet, Surrey, where A.P.T. Electronic Industries Ltd. have their factory and offices, and will continue to market "Cybervox" language laboratories and "Saki" keyboard training machines.

The Ilford Group of Companies has acquired **Zonal Film (Magnetic Coatings) Ltd.** Zonal products will complement the range of magnetic materials which Ilford already market. Future plans, outlined by Mr. G. A. Jones, commercial director of Ilford Ltd., included the development of new magnetic recording materials designed specifically for videotape and computer applications. Zonal Film (Magnetic Coatings) Ltd. will be operated as a separate manufacturing company within the Ilford Group.

A.M.P. Aircraft-Marine Products (G.B.) Ltd., makers of crimped terminals, announce they are to set up a new production unit at Bideford, North Devon. The factory will be built in two stages and while the first 15,000 sq ft is being constructed the new production unit will be housed in a temporary factory. The second stage provides for a further 15,000 sq ft and will be completed within the next three to five years.

£5M Undersea Cable Order.— Standard Telephones & Cables and Submarine Cables Ltd. have each received orders valued at £2.5M from Cable & Wireless Ltd. for undersea cable and associated equipment for the first section of SEACOM, the South-East Asia Commonwealth telephone cable system. This section will link Jesselton in Sabah (formerly North Borneo), Hong Kong and Singapore. The laying of the 2,000 nautical miles of cable, with repeaters every twenty miles, is expected to be completed later this year and to be opened for public service next February.

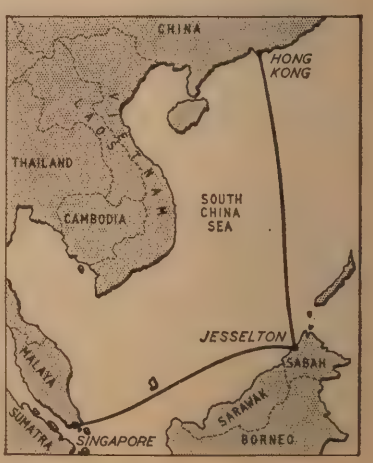
As can be seen from the map, the first section of SEACOM will link Singapore, Jesselton and Hong Kong.

Livingston Group. — Circetch Ltd., printed circuit board manufacturers of Bognor Regis, have been acquired by Livingston Holdings Ltd. the parent company of the Livingston Group. It is also announced that the recently acquired company, re-named Livingston Burge Electronics, has been merged with Livingston Control Ltd. which now comprises three divisions covering electronic organs, control equipment and components. Livingston Control has closed its Retcar Street, London, premises and has taken over a 16,000 sq ft factory adjoining the Burge electronic organ factory at Watford, Herts. Mr. D. C. Rennie, managing director of the group, is general manager of both Watford factories.

Unicam Instruments Ltd., Cambridge, members of the Pye Group, announce an agreement with Ernst Leitz G.m.b.H., Wetzlar, for the marketing of **Unicam spectrophotometers in West Germany.** Ernst Leitz already have an interest in spectroscopy which is complementary to that of Unicam. Both companies will retain complete independence of operation in all other fields.

Decca Radar Ltd. have produced an **electronic alarm** for the detection of intruders. The system depends on the generation of ultrasonic Doppler frequencies, which are detected and used to operate the alarm. Transistors are used throughout and all circuits fail safe.

DEAC (Great Britain) Ltd. have moved their main factory to Crewkerne in Somerset. The new unit, which is twice as large as the Slough factory, will manufacture the whole range of button cell batteries with the exception of the 20DK and 50DK types.



Rank-Bush Murphy Electronics announce the formation of three new marketing units: Rank Telecommunications; Rank Medical Equipment; and Rank Nucleonics & Controls. These marketing units will handle all the products previously sold by Murphy Electronics, General Radiological, and the electronics section of Bush Radio. A fourth unit, a military and contracts section, will continue to operate under the name of the parent, Rank-Bush Murphy Electronics.

A new company, **Douglas A. Lyons & Associates Ltd.,** has been formed by Douglas Lyons, who was until last year the managing director of Trix Sound Equipment, to provide import and export facilities. Mr. Lyons already has exclusive U.K. agency rights for a number of overseas audio products, including LEM and BOUYER microphones, and DNH industrial loudspeakers.

The General Data Corporation, of Orange, California, whose products include analogue/digital converters data amplifiers, a.c./d.c. converters and a range of equipment for data logging and industrial control, have appointed Bendix Electronics Ltd., of New Basford, Nottingham, as their sole U.K. agents.

A new department has been set up within Industrie Elettriche di Legnano of Milan, to handle the marketing of **Ferranti automatic control systems in Italy.**

French Agents.—SIEDMA S.A. (Société Importation Exportation Distributrice Matériel Anglais) of Paris, have been appointed exclusive agents for the specialized components division of the Marconi Company.

Princetown Applied Research Corporation, of New Jersey, U.S.A., have appointed Rank Cintel, of Worsley Bridge Road, London, S.E.28, U.K. marketing agents for the full range of electronic instruments and systems they manufacture.

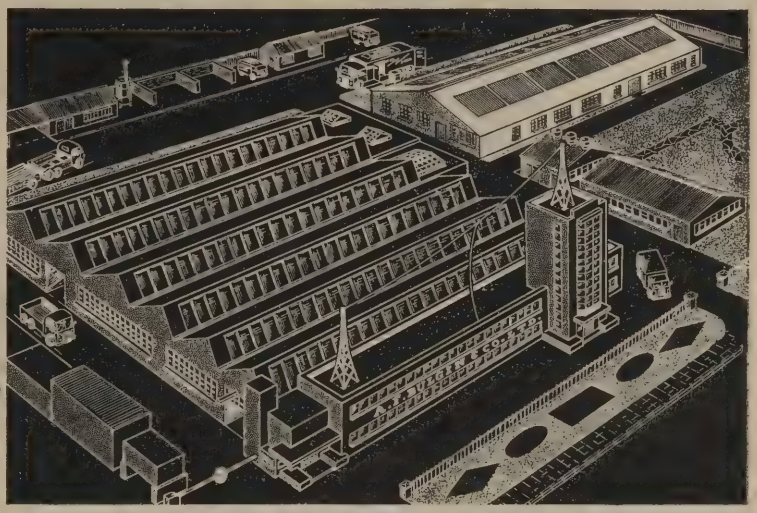
Solitron Devices Inc., of Norwood, N.J., semiconductor manufacturers, have appointed Auto-Electronics Ltd., of Peel Grove, London, E.2, to act as their U.K. distributors.

To facilitate the distribution of their products in the South, **Welwyn Electric Ltd.,** of Northumberland, have appointed the Radio Resistor Co. Ltd., of Palmerston Road, Wealdstone, Harrow, Middx., their stockists and distributors.

(*Continued on page* 324)

NEW FACTORY EXTENSION

PROGRESS BUILT ON QUALITY AND SERVICE



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From small, beginnings in 1923 the House of Bulgin has over the years expanded into an efficient, highly automated company producing the Largest Range of Electronic Components in the World.

Now in 1964, after a record sales year and often making many additions to our vast range of products which can be seen on our

STAND NO. G.83., I.E.A. EXHIBITION, OLYMPIA, 25-30TH MAY 1964,

our present factory is being enlarged by the construction of Double-Width Single-Span Building pictured above.

This additional area will be equipped with the most up-to-date machinery and plant, to meet the present demand for components of the highest precision. In addition a new electricity Transformer Station large enough to cater for any foreseeable future development is being built on the site.

With this new plant and a promising trading year ahead, we look forward confidently to the future and can assure all our customers both at home and abroad of our continued assistance and interest in all matters concerning the manufacture of Electrical & Electronic Components.

COMPREHENSIVE CATALOGUE REFERENCE No.203 2C.

The latest edition of our General Catalogue is now available price 2/6d. post free or free to Trade Letterhead and Order. Recently redesigned in a new, modern, easy to use format its 184 pages give full technical details, dimensions and illustrations of

OVER 10,000 ELECTRONIC COMPONENTS

including many new lines which have been developed during the past year. Please quote the above reference number on application.

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Using a high-pressure process, Standard Telephones and Cables are manufacturing synthetic crystals at their Harlow, Essex, factory. The process takes three weeks.

Television translators for four "pockets" along the northern coast of **Jamaica** have been ordered from Cossor Communications Company by the Jamaica Television Company. The island's television service operates in the v.h.f. band on 625-lines in 6 Mc/s channels.

Elliott-Automation group pre-tax profit for 1963 rose to £3.24M from £2.86M in 1962. Net profit for the year, after providing for depreciation (£979,142) and taxation (£1,341,000), amounted to £3,237,513. This represents an increase of £375,000 on the previous year's results.

BSR Ltd. group trading profit for 1963 amounted to £2,342,876 and showed an increase of £231,652 on the previous year's result. After providing £1.1M for taxation, profit for the year totalled £1,310,162 (£1,086,928).

Chloride Electrical Storage Co. report a group pre-tax profit of £3,532,130 for 1963. This shows an increase of almost £500,000 on the previous year's results.

Marconi Instruments Ltd. have opened a 32,500 sq ft extension to their St. Albans works, which houses their research and development laboratories, and administration offices. This brings the total floor area to 219,500 sq ft.

Brush Clevite Company is the new name of Brush Crystal Company, of Hythe, Southampton, which is a member of the Clevite Corporation, of Cleveland, Ohio.

Data-logging and monitoring equipment, providing a continuous watch on all temperatures, levels, pressures, etc., of the main engine and auxiliaries in two 9,100-ton refrigerated cargo vessels, is to be supplied by English Electric-Leo Computers Ltd. These 350-channel systems will also monitor the temperatures in the refrigerated space in these vessels being built for Shaw Savill and Albion Co.

General Radio Company (U.K.) Ltd. has been formed by General Radio Company of West Concord, Mass., to operate a sales and service headquarters in the U.K. The new company, of which the directors are I. Sichel (managing), M. H. Evans and D. E. Schonhut, will "support and supplement the existing sales and service activities of the Claude Lyons organization" who have been G.R. agents for nearly 40 years. Temporary offices are at Westminster Bank Chambers, Bridge Street, Leatherhead, Surrey (Tel.: Leatherhead 2671), but a new factory and offices are being built at Bourne End, Bucks.

Industrial Instruments Ltd. have recently combined with Transipack Electronic Engineers and have taken premises in Stanley Road, Bromley, Kent (Tel.: RAVensbourne 9212). Mr. W. Kiryluk is technical director of Industrial Instruments.

The servicing of **Akai tape recorders,** which are imported from Japan by the Pullin Optical Company, of Perivale, Middx., is being undertaken for them by Sound Equipment Servicing Co. Ltd., of 163 Lower Richmond Road, London, S.W.15. (Tel.: PUTney 1021.)

Vactric Control Equipment Ltd., manufacturers of precision electromechanical servo components, have moved from London into a new factory and offices in Garth Road, Morden, Surrey.

Ray-O-Vac.—Alpha Accessories Ltd., of H.M.V. House, 363 Oxford Street, London, W.1, have changed their name to Ray-O-Vac (U.K.) Ltd.

U.S. Trade Mission.—Five representatives of the United States electronics and automation industry are visiting the U.K. from 12th May to 2nd June "to promote mutually advantageous trade and investment" between the two countries. Information is available from the American Embassy, Grosvenor Square, London, W.1. (Tel.: GROsvenor 9000, Ext. 445.)

Venezuelan Microwave Network.—General Telephone and Electronics International, of Geneva, have been awarded a contract for the first phase of a $12 million microwave network in Venezuela, which will replace the present overhead wire lines between Caracas, Maracay, Valencia and Barquisimeto. The entire 620-mile system, in which 23 repeater stations are to be used, is expected to be completed in 1967. Capacity of the completed system will be six radio channels, each capable of carrying 960 voice circuits.

CLUB NEWS

Durham.—The Durham City Amateur Radio Society, which was formed in January and meets on alternate Thursdays at 7.30 at the "Bridge Hotel," North Road, is holding a constructional competition on June 4th.

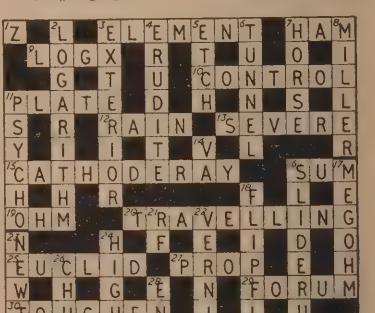
Gt. Yarmouth.—The region of the R.S.G.B. covering Norfolk, Suffolk and Essex is holding a regional meeting at Great Yarmouth on 14th June. It is being organized by the Gt. Yarmouth & District Radio Club.

Longleat.—The seventh annual mobile rally to be held in the grounds of Longleat House, Warminster, will be on 21st June. Talk-in stations will be operating in the 2-metre band (G3SJI/A) and in the vicinity of 1,885 kc/s (G3JMY/A). The rally organizer is E. C. Halliday, 4 Parkside Avenue, Winterbourne, Bristol.

Loughton.—Meetings of the Loughton & District Radio Society are held on alternate Fridays at 7.30 at Loughton Hall, Debden Community Centre, Rectory Lane. During the Debden Fair Week (11th-18th July) the club will be operating station GB3LOU on all bands and is also planning a mobile rally and an amateur television demonstration by G3MJZ/T.

A Crossword for Numerates

Solution to the puzzle set by A. J. Key on page 257 of the May issue.



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Transistorised **INTEGRATED AMPLIFIER**

Dimensions: 13ins. x 4¼ins. x 9ins. deep. Weight: 14lbs. **Price £49 10s 0d.**

. . . superb styling, faultless performance and a breakthrough in price and reliability by LEAK . . . the First Name in High Fidelity

Reprinted from "WIRELESS WORLD" Editorial May 1963 ". . . Last autumn, during his presidential address to the British Sound Recording Association, H. J. Leak demonstrated a prototype high-quality transistor amplifier which gave results indistinguishable from those of his valve amplifiers . . ."

"People sometimes ask why there is any necessity to change to transistors. The elimination of the output transformer is, in our view, sufficient reason now that solutions of the problem of linearity in the response of the rest of the transistor circuit have been found. As additional bonuses we get smaller size, cooler running and the prospect of longer life."

- **Compared with its equivalent valve amplifier the "Stereo 30" gives results which are indistinguishable and it offers these important advantages:**
  - It is 48% of the weight.
  - It is 43% of the size.
  - It is 89% of the price.
  - It has greater reliability (estimated to be 500% better) because the heat rise within the case is negligible (12°F) and because the maximum voltage is less than 50.

How can the valve possibly survive in view of the above comparisons?

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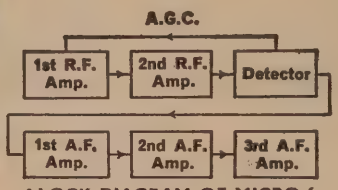

BLOCK DIAGRAM OF MICRO-6

- **SIZE $1\frac{4}{5}$" x $1\frac{8}{10}$" x $\frac{1}{2}$"** (4.6 x 3.4 x 1.2 cm.)
- **WEIGHS LESS THAN 1 OZ.** (28 gms.) **COMPLETE WITH BUILT-IN FERRITE-ROD AERIAL AND 2 MERCURY CELLS**

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Although the Sinclair Micro-6 has been designed to standards of compactness never before thought possible, building is simple and straightforward when the meticulously detailed instructions are followed. All parts including MAT transistors, diodes, printed circuit board, lightweight earpiece, case and dial, and well printed instructions come to

59/6

Two Mercury Cells should be used for maximum performance.

MALLORY MERCURY CELLS for Micro-6, 1/11 ea.

"TRANSRISTA" WRIST STRAP to take Micro-6. Elegantly styled in quality nylon, black or grey. **7/6**

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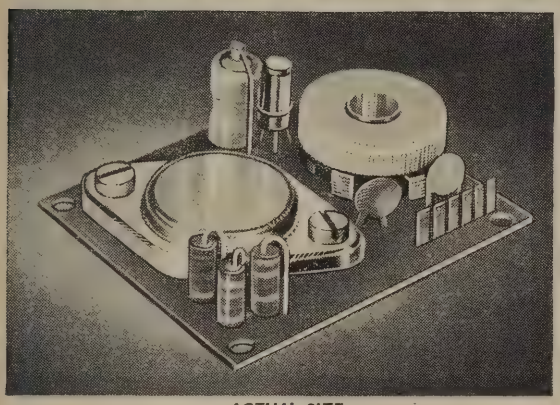


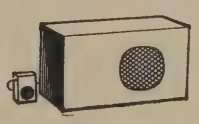
ACTUAL SIZE

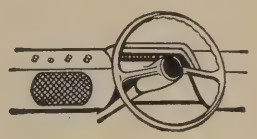
THE TR 750 HAS TREMENDOUS POWER

This latest Sinclair power amplifier builds on to a printed circuit board 2in. square and includes its own volume control with on-off switch. With a transformerless output of 750 milliwatts, the TR750 is primarily intended to provide powerful loudspeaker reproduction from the Sinclair Micro-6 or Slimline receivers, thus enabling owners of these sets to use them also for car-radios, loudspeaker portable or domestic sets. The TR750 has many other applications. It makes an excellent record reproducer, singly for mono or paired for stereo. It can make the heart of an efficient intercom or baby alarm system and its enormous power in relation to its size greatly enhances its usefulness. Quality is superb.

BRILLIANT PERFORMANCE

Performance characteristics are brilliant —¾ watt transformerless output with frequency response within ±1dB from 30 to 20,000 c/s—hi-fi by any standards! Input—10mV into 2K ohms for 750 milliwatts output into any standard 24 to 35 ohms loudspeaker. Operating requirements from 9 to 12 volts.





Full building instructions are supplied with parts for the TR750, which includes latest type Micro-Alloy driver and our important new "Magnagain" power transistors, micro-miniature components including volume control and on-off switch, printed circuit board and input plug for connecting to Micro-6 or Slimline.

Ready built and tested

39/6

45/-

TR750 POWER AMPLIFIER

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SINCLAIR MICRO INJECTOR

TEST PROBE

Provides a simple, highly efficient and economical way to trace faults. Two Micro-Alloy, Transistors (MATs) are used. Generates and injects a signal at a frequency from 1 kc/s to 30 Mc/s-1¼in. × 1⅞in. × ½in. plus probe.

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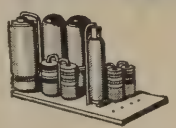
MICRO-AMPLIFIER



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An ideal broadband R.F. Amplifier. Frequency response from 30 to 50,000 c/s. ±1 dB. power gain 60 dB (1,000,000 times). Also makes a sub-miniature hi-fi amplifier with an output suitable for any earpiece or even loudspeaker and is an invaluable tool in the hands of the keen experimenter.

With MATS, micro-miniature quality components, printed circuit board, printed circuit, and instructions for building and using with pick-ups, micro-radio receivers and transmitters, microphones, etc. Parts come **28/6**

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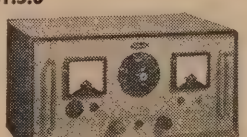

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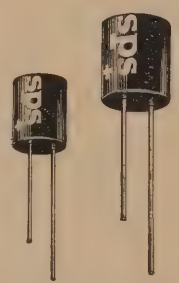

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Capacitance: —20% + 100% of rated capacity.
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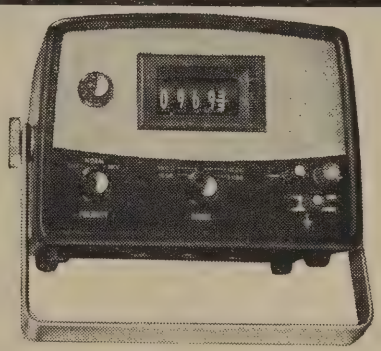

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THE CONNOISSEUR'S CHOICE

"none genuine without this seal"

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BAKERS SELHURST LOUDSPEAKERS, FOR NATURAL SOUND	Retail PRICE	Input watts	Frequency Range c/s.
12in Stalwart (Public Address)	5 gns.	15W	45-13,000
12in. Stalwart Foam (Hi-fidelity)	6 gns.	10W	40-14,500
12in. Standard (Heavy Duty)	7 gns.	20W	40-14,500
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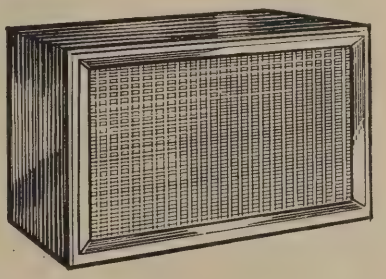

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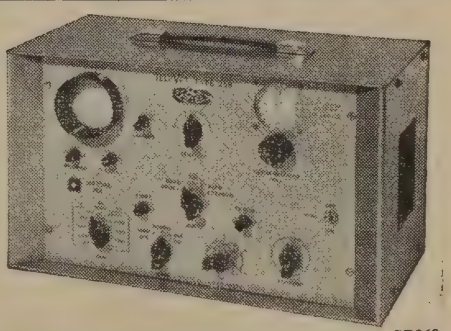

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2 KW. Peak Starting. 650 W. Continuous. 50-60-400 c/s. or D.C. from 12-24-50 v. Battery. Up to 93% Efficiency. Polarity Reversal Protection. Square or Sinewave. Up to 300% Instant Overload Capacity. Manually Controlled Frequency. Reed Type Indicator. Remote Control Facilities.

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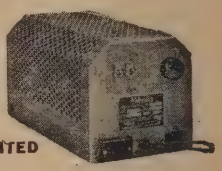
Range of models available with prices from £11-£90.

Please write to department C.10 for transverter leaflet.



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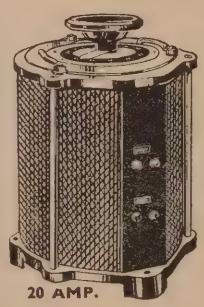
VARIABLE VOLTAGE TRANSFORMERS

INPUT 230 v. AC 50/60~



20 AMP.

BRAND NEW. Carriage Paid. Buy direct from the importer, keenest prices in the country. All Types and Spares available from stock.

We are pleased to announce further additions to our range:

Type 1	0-260 v. at 1 amp ...	£4 10 0
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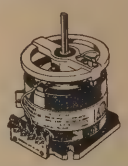
Type 3	0-260 v. at 5 amps ...	£9 0 0
Type 4	0-260 v. at 8 amps ...	£14 10 0
Type 5	0-260 v. at 10 amps...	£16 10 0
Type 6	0-260 v. at 12 amps...	£18 15 0
Type 7	0-260 v. at 20 amps...	£32 10 0

2.5 AMP.

These instruments are fully shrouded.

1 AMP. OPEN TYPE



(Type 1A.) Compact, well constructed unit designed for building into equipment. Panel or back mounting, extending shaft. Complete with engraved voltage panel and control knob. Input 230v. A.C. Output variable 0-260v. Ideally suited for Manufacturers of variable voltage equipment.

Price: **£4 17 6d.** post paid.

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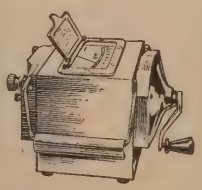
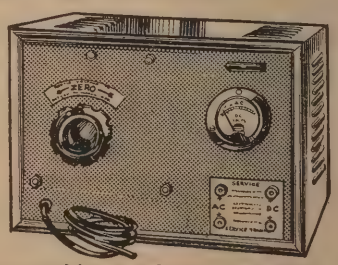


Test to I.E.E. Spec. Rugged metal constructed, suitable for bench or field work, constant speed clutch. Size L. 8in., W. 4in., H. 6in. Weight 6lb. 500 volt, 500 megohms. Price **£22**, carriage paid. 1,000 volts, 1,000 megohms, **£28**, carriage paid.

7 Ampere A.C./D.C. VARIABLE OUTPUT UNIT



Input 230 v. A.C. Output continuously VARIABLE from 0 to 260 volts A.C. OR 0 to 230 volts D.C. at 7 amps. Robustly constructed in metal case, complete with safety fuse, neon indicator and voltmeter. Size 17in. x 12in. x 7in. Weight 36lb. Price £34/10/-. Carriage 20/-.

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Transformer to suit the above. Input 200-240 A.C. 12 volt 36 watt, **16/6**; P. & P. 2/6. Input 200-240 A.C. 12 volt 60 watt, **22/6.** P. & P. 3/6.
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H96A, 2.2 ohm + 2.2 ohm, new **12/6.**
H96B, 50 ohm + 50 ohm, new **12/6.**
H96C, 145 ohm + 145 ohm, new, **12/6.**
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H96E, 1700 ohm + 1700 ohm, ex-equip., **16/6.**
P. & P. 1/- on each Relay.

CARPENTER'S POLARISED RELAY. Type 5A57, 65 ohm. coil will operate on less than .5 of a volt. **22/6.** P. & P. 1/–.

P.O. RELAYS, Type 3,000
200 ohm., 6 c/o 6,500 ohm., 1 c/o 1 break.
500 ohm., 6 c/o 16,000 ohm., 2 make 2 break.
500 ohm., 4 Heavy Duty Make.
2,000 ohm., 4 make 4 break.
All at **12/6** each, plus 1/- P. & P. each.

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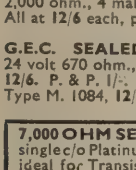

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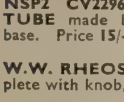

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HIGH SPEED BLOWER UNIT
200/250 volt A.C. Powerful 2-speed motor, 11,000 and 13,000 R.P.M. **17/6,** plus 2/6 P. & P.

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Type B16G 80 r.p.m. .26lb. inch £1/19/6. P. & P. 2/-.
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230 Volt AC 50 c/s 5-figure Veeder-root Counter (not resettable). New. Boxed. **19/6,** plus 2/6 P. & P.

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3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. operation. Ex equip. Individually tested. **22/6,** plus 2/6 P. & P.

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OC29	18/–	OC203	14/–
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OC45*	5/–	Get 105	10/–
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OC72*	7/–	2G110	17/6
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OC77	9/–	TK20B	4/–
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*Available in Matched Pairs.

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OA91	3/–	1S111	4/–
SX781	4/–	ZS10B	3/–

ZENERS 5%
All ¼ watt 5% at **10/-** each, 4.3 v., 4.7 v., 5.1 v., 5.6 v., 6.2 v., 6.8 v., 7.5 v., 8.2 v., 9.1 v., 10 v., 12 v., 15 v., 16 v., 22 v.

INSULATED TERMINALS available in black, red, white, yellow, blue and green. New **15/-** per doz. P. & P. 1/-.

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Type 1. Pri. 200-240 sec. tapped 30, 32, 34, 36 volt at 5 amp., **57/6.** P. & P. 4/-.
Type 2. Pri. 240 sec. tapped 30, 40 and 50 volt at 5 amp., **£4/15/-.** P. & P. 4/-.
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5 amp. D.C. M.I. 2½in. fl. rnd.	11/6
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0-350 mA. T.C. 2in. fl. rnd.	8/6
500 microamp M.C. 2½in. rnd. fl. scaled 15/600 volt. NEW	16/6

500 MICROAMP SUB-MINIATURE M/C METER
1¼in. diameter, flush mounting, single hole fixing. Scaled 0-1 mA. Supplied with Resistor for use as 1 mA. if required. **29/6,** plus 1/- P. & P.
Postage on all meters, 1/- each.

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4 DIAL DECADE RESISTANCE BOX

Range 0-11,110 ohm. X1 Wire Wound, Max. current 300 mA. X10 Wire Wound, Max. current 150 mA.
X100, X1,000. High Stability Resistors, rated 1 watt. Accuracy + —1%.
Switches, make before break type, fitted with low resistance silver plated contacts, polished wood case, new, **price £10/10/-,** plus 6/6 P. & P.

BUILD AN EFFICIENT STROBE UNIT FOR ONLY "37/6"
The ideal instrument for workshop, lab or factory. This wonderful device enables you to "freeze" motion and examine moving parts as if stationary. We supply a simple circuit diagram and all electrical parts, including the NSP2 Strobe tube which will enable you to easily and quickly construct a unit for infinite variety of speeds, from 1 flash in several seconds to several thousands per minute. New, modified circuits bring price down to **37/6,** plus 3/- P. & P.

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Incorporating a 4 Sp. Garrard Auto-Slim unit and Mullard latest 3 w. amplifier (ECL86 and EZ80), vol., bass and treble controls, with 8 × 5in. 10,000 line speaker. Superb quality reproduction. Contemporary styled two-tone cabinet, charcoal grey and off-white with matching blue relief. Size 17½in. × 16in. × 8in.

COMPLETE KIT. £13.19.6
(Carr. & ins. 10/-)

Cat. & Const. details 2/6 (free with kit).

FRONT SECTION, which houses amp & spkr is detachable from cabinet. Price, as separate unit for stereo, £5/17/6. Carr. 5/-.

COLLARO STUDIO TAPE RECORDER KIT. Regret all complete kits of this popular unit now sold out. Only a few cabinets and Collaro Tape Decks remain—NO AMPLIFIERS LEFT. Cabinet size: 18 × 16½ × 6in. with cut-out mounting board. **SPECIAL CLEARANCE OFFER**—Twin track: £13/10. 4-track: £17/10/- (plus 10/- carr.).

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SINGLE PLAYERS: Carr. 4/6.
Model SRP10 5 gns.
Model 4HF £16/10/-. Carr. 7/6.
AUTOCHANGERS: 4 speed. Carr. 5/-.
Latest Model AT.6 with transcription arm, plug-in head, mono. 10 gns. Stereo 11 gns. "Autoslim" Model £6/17/6.

BONDACOUST Speaker Cabinet Acoustic Wadding (1in. thick approx.), 12in. wide, any length cut, 1/6ft., 4/- yard.

TYGAN FRET (Contem. pat.), 12 × 12in. 2/-; 12 × 18in. 3/-; 12 × 24in. 4/-, etc.

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Famous American Columbia (CBS) Premier quality tape at NEW REDUCED PRICES. A genuine recommended Quality Tape—TRY IT Brand new, boxed and fully guaranteed. Fitted with leader and stop foils.

Standard		Double Play	
5in. 600ft.	13/-	1,200ft...	31/6
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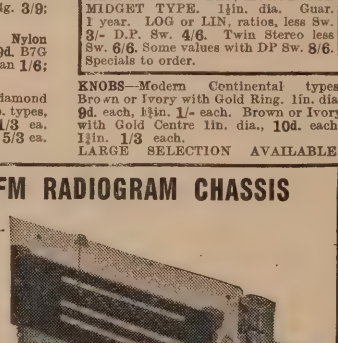

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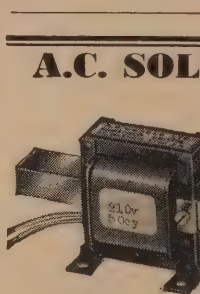

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Terms cash with order.
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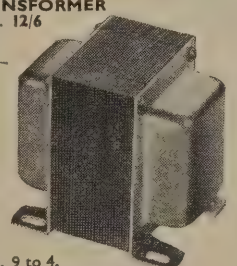
Hours of Business Mon. to Fri. 9 to 6. Sat. 9 to 4.



Transformers Constructed to Customers' Specifications

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Wilkinsons

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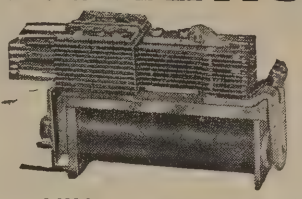

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P.O. TYPE 3000 AND 600
Built to your own specification
Keen Prices
Quick Delivery
Contacts up to 8 changeover

MINIATURE SEALED RELAYS SEND FOR LIST

RELAYS MAGNETIC SOLENOID OPERATED
24 volts D.C. 4 make and 4 break 10 amp. contacts. 5C/3944. Brand new, complete with dust cover, **12/6** each, post 2/-.

EVERSHED & VIGNOLES WEE MEGGERS 500 volt SERIES 3 BRAND NEW in leather carrying case £19-10-0d.

KEY SWITCHES (3 position). P.O. 212. 2 Changeover each side, **6/6.**
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Other types available.
Knobs, **6d.** Plates, **1/-.**

FREQUENCY METERS. 45-55 cycles per second, 230 volt, 6in, dia. Flush Round. Brand new in maker's box. **£10/10/-.** post 5/-.
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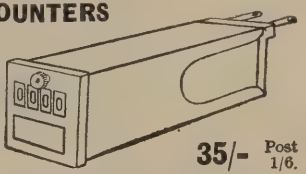
SMALL IMPULSE COUNTERS

High Speed Type
10 IMPULSES PER SEC.
WITH 4 DIGITS
100v., 50v., 24v., 12v., or 6v. D.C.
WITH SLIDE-ON METAL COVER 3½ x 1 x 1in.



SPECIAL PRICES FOR QUANTITY. STATE NUMBER REQUIRED.

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BEST MAKES ★ DELIVERY OFF THE SHELF ★ SEND FOR LISTS

2½in. Moving Coil Flush Round
0/1 amp.; 0/5 amp.; 0/10 amp.; 0/20 volts; 0/40 volts; all at **35/-** each. 0/30 amps. **42/6.**
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0/1 Milliamp at **37/6. Postage on all meters 2/-.**
CATHODE RAY TUBE. 139A. 2½in., **25/-.** Post 2/-.

TERMINAL BLOCKS. 2-way 5C/431 or 3-way 5C/432, **6/-** per doz., 50 for **22/6,** 1,000 for **£16/10/-.**

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base.
IMHOF MAINS BLOWERS. For cooling 19in. rack mounted equipment, with glassfibre filter and directional duct, **£15.** Blower only **£12/10/-.**

WESTALITE BATTERY CHARGERS. Made by Westinghouse (type BC14–6/40). Input 200/250 v. A.C. will charge 6-volt or 12-volt batteries at 0/40 amps. Coarse control switch with eight positions and fine control switch with four positions including "off." Built-in 0-50 ammeter. Fused A.C. and D.C. 24in. × 14in. × 13in.; **£39/10/-** each. Carriage 20/-.
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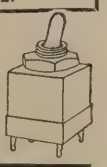
12/- per dozen 75/- per 100

SINGLE-POLE Double Throw, 3 amp. 250 A.C.
Can be used as ON/OFF or CHANGE-OVER SWITCH



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Escutcheons (Windows). 8/6.
Knobs. Medium size. Set of 8. 15/-.
Block Condenser (3 x 4 mfd.). 15/-.

CONSTANT VOLTAGE TRANSFORMERS. Input 190 to 260 volts. 50 c.p.s. Output 115 volts at 2 kVA. A pair of these will give a constant output of 230 volts at 4 kVA. Price £15 each, plus £1 carriage. Two for £30. Carriage paid.

HEAVY DUTY BLOWERS
For 200-250 v. A.C./D.C. mains, 300 watts. With 1½ inch diam twin "V" shape outlets. 2 lengths of hose. 4 spare filters and brushes. Suitable for industrial use, forges, etc. Brand new. £4/19/6. Carr. 10/6.

MILLIAMMETERS
Panel meter 0-1 milliamp. Flush mounting circular. Barrel diameter 2¼in., outside diameter 3¼in. Dials are scaled 0-100. Resistance is 75 ohms. Fe & NFe. BRAND NEW. 25/-. P. & P. 1/-.
Meter Rectifiers (S.E.I.). 1 mA. 8/6.
Westinghouse 5 mA. 7/6.

MICROAMMETERS
R.C.A. 0-500 microamps. 2½in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. 15/-.

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0-300 volts, 25-100 c/s. Moving iron. 6in. scale. Fl. mtd. Hermetically sealed, grade 1N. Made 1955. BRAND NEW. Boxed 79/6. Post 4/-.

INDUSTRIAL METER. Iron clad. 0 to 300 v. A.C. 50 cycles. Moving iron, 6in. scale Fl. mtg. BRAND NEW. 59/6. P. 4/-.

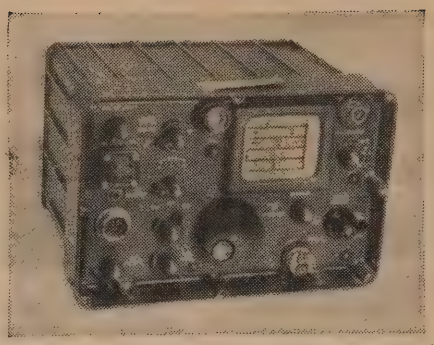
E.M.I. MEASURING OSCILLOSCOPE TYPE WM 2
An accurate modern 5in. mains operated 'scope for the examination of waveforms up to 12 Mc/s. Includes such features as "X" expansion, continuous 6 : 1, flat aluminised screen, etc. Scarcely used condition complete with instruction manual. Fully guaranteed, £65.

COSSOR DOUBLE BEAM OSCILLOSCOPE TYPE 1035
A modern oscilloscope in good working order. Fully guaranteed. £37/10/-. Carr. 30/-.
SPARE TUBES for this 'scope. Type 89D. BRAND NEW. 59/6. P. & P. 4/6.

LAVOIE LABORATORIES TS-127/U WAVEMETER
An American made wavemeter covering 375 to 725 Mc/s. Individually calibrated charts. Resonance is indicated on a 3in. square 0 to 200 microammeter. 9in. x 11in. x 7in., wt. 17 lbs. A beautiful job in new condition. £3/19/6. Carr. 7/6.

MARCONI SIGNAL GENERATOR TF-517.
Three ranges. 18 to 58 Mc/s in 2 individually calibrated ranges and 160 to 300 Mc/s. by indirectly calibrated dial. A.C. mains operation. **AS NEW CONDITION** in original transit cases with instruction book. £7/10/-. Carr. £1.

STANDARD TRANSFORMERS
Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4 x 3½ x 2½in. ALL BRAND NEW. 18/6 each. Post 2/6.
Type 1. 250-0-250 v. 80 m/a., 6.3 v. 3 a. tapped at 4 v. 4 a., 6.3 v. 1 a., tapped at 4 v. and 5 v. 2 a.
Type 2. As above but 350-0-350 v. 80 m/a.
Type 3. 30 v. 2 a., tapped at 12, 15, 20 and 24 v. to give 3-4-5-6-8-9-10 v., etc.
Type 5. 0-6-9-15 v. 4 a. Ideal for chargers.



RECEIVER TYPE R-216 is a 16-valve superhet receiver for A.M., F.M. and C.W., covering 19 to 157 Mc/s. in 5 turret switched ranges. Two crystal calibrators (5 Mc/s. and 1 Mc/s. B7G glass Xtals) are provided for absolute accuracy. Two R.F. and 4 I.F. stages ensure exceptional performance. Film strip tuning scale, fantastic reduction ratio drive, R.F. and L.F. gain controls etc. Deviation ratio (bandwidth) on F.M. 30 Kc/s or 120 Kc/s. Low impedance 'phone output. Size 8½ x 12½ x 9in. Wt. 25lb. Matching A.C. mains power unit (metered), weighs 20 lb. Complete with all connecting leads, circuits, etc., ready to operate and in BRAND NEW condition. £29/10/-. Carr. 30/-.

AR-88 SPARE VALVES. Complete set of BRAND NEW individually boxed original valves (14). £2/10/-. P. & P. 2/6.
AR-88 VIBRATOR PACKS. For 6 v. operation. Complete with vibrator and OZ4 rectifier. BRAND NEW in original cartons. 17/6. P. & P. 2/6.

MAGNETIC COUNTERS (Ex-G.P.O.). 4 figures to 9,999 Coils 500Ω for 24 v. operation. Tested. (No reset.) 5/- each. P. & P. 1/6. SPECIAL OFFER. 10 for 30/-. P. & P. 5/-.

RELAYS G.E.C. MINIATURE SEALED

M–1095.	670 2M 2B H/D Wire Ends.....	7/6
M–1099.	670Ω 2M H/D Wire Ends.....	7/6
M–1052.	5,000Ω 2/CO. Plat. Wire Ends	10/–
M–1493.	670Ω 4/CO. Plat.....	12/6

ALL BRAND NEW and BOXED. Please add postage.

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25 positions, 8 bank double wipers, 50 volt operation. Ex-equipment and tested. 45/-. Post 2/6.

ELECTRONIC FREQUENCY CONVERTER CV-253/ALR. Ex U.S.A. equipment of recent design (1956). Covers 38 to 1,000 Mc/s. in four switched bands as follows: 38 to 130, 130 to 300, 300 to 550 and 550 to 1,000 Mc/s. Can be directly used with the APR-4 search receiver or, if a power supply is provided, into any 30 Mc/s. receiver or IF strip. Directly equivalent to all three tuning heads as used in the APR-4. **BRAND NEW. £45.**

PCR COMMUNICATION RECEIVERS
All sets are in PERFECT WORKING ORDER and give very fine results on short waves. PCR-2 £5/19/6, PCR-3 £8/8/-. **CARRIAGE** (any type), 10/6. S.A.E. for details.
POWER SUPPLIES. The above receivers require 250 volts HT and 12 volts LT. We will supply any of the above receivers fitted with a **BRAND NEW INTERNAL POWER SUPPLY** for £2 extra. Fully guaranteed ready for use on A.C. mains.

STANDARD SIGNAL GENERATOR MARCONI TF-144G/4 £16/10/- Carr. 30/-
Complete and in apparently very good condition but sold as received from the Air Ministry, i.e., untested and less leads. Technical manual and circuit supplied. We assure potential customers that "untested" does NOT mean "beyond economical repair" but are willing to supply GUARANTEED WORKING instruments complete with leads, etc., for £25.

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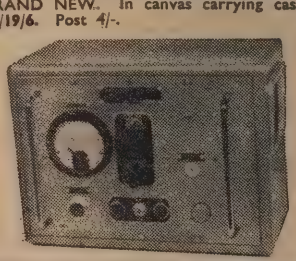
MICRO-WAVE EQUIPMENT
TS-148/UP (AN/UPM-33) AMERICAN SPECTRUM ANALYSER. Checks frequency of TR and TB cells, signal generators, local oscillators and magnetrons. Measures pulse width, RF spectrum width and "Q" of resonant cavities. Frequency range 8,500 to 9,600 Mc/s. Internal power supply for 115 volts 50 c/s. In first-class condition. £100.

ADVANCE SIGNAL GENERATOR Type LI. A first grade laboratory type instrument covering 300 to 1,000 Mc/s. Directly calibrated dial. Direct reading attenuator. A.C. mains operation. Pulse and sine wave modulation (variable pulse width). Original price £375. As new. £120.

HEWLETT PACKARD 205 AG. An American audio signal generator of the finest quality. Ranges 20 to 200, 200 to 2,000, and 2,000 to 20,000 c.p.s. Output is 5 watts. Fully variable attenuator 0 to 110 dB in 1 dB steps. Output impedances 50, 200, 500 and 5,000 ohms CT ungrounded. Input and output monitor meters. Operation from 110 volts A.C. mains. Electrically perfect but wooden cases may be slightly damaged. £30. Carr. 30/-.

RADIATION METERS
Portable dose rate meter containing modern type rectangular 50 micro-amp meter CVX 494, electrometer valves, etc. BRAND NEW. In canvas carrying case. £3/19/6. Post 4/-.



MARCONI TF987/1 NOISE GENERATORS. DETERMINE NOISE FACTOR of A.M. & F.M. receivers. A.C. mains operation. Stabilised H.T. AS NEW. Tested, £15, carr. 7/6. SLIGHTLY USED (but tested). £8/19/6, carr. 7/6.

TS-175 HETERODYNE FREQUENCY METER
A high frequency version of the well-known BC-221. Accuracy 0.05%. Frequency range 80 to 1,000 Mc/s. As new condition with original calibration book. Tested and guaranteed. £75.

LM-14 HETERODYNE FREQUENCY METER
Naval version of the BC-221. 125 Kc/s. to 20 Mc/s. Undoubtedly superior to the BC-221 in construction and performance. Requires 12 or 24 v. LT and between 200 and 475 v. HT (self stabilised). A particularly useful feature is variable RF coupling and modulation is also available. With correct individual calibration books. Unused and guaranteed. £25. P. & P. 7/6. Separate power unit for A.C. (if required). £4/10/-. P. & P. 5/-.

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A precision instrument covering 8.9 to 15.5 Mc/s. and 20 to 300 Mc/s. in six ranges. Variable attenuator from 1μV to 100 millivolts. A.C. mains operation. Good condition, tested and complete with calibration chart. £16/10/-. Carr. 10/-.

MOVING COIL PHONES. Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 22/6. Post 1/6.

HEAVY DUTY L.T. TRANSFORMERS. (Gresham). Latest type potted, oil filled. Pri. 230 v. 50 c/s. Sec. 0-70-75-80 v. 4 amps. Size 5½ x 4½ x 6½in. high. Wt. 19 lb. BRAND NEW. 32/6. Carr. 5/-.

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FEATURES:

- ★ Ready-built amplifier with 4 first grade Mullard transistors
- ★ Plays 45 r.p.m. Pop records
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- ★ Crystal pickup with expendable stylus GP59 Type
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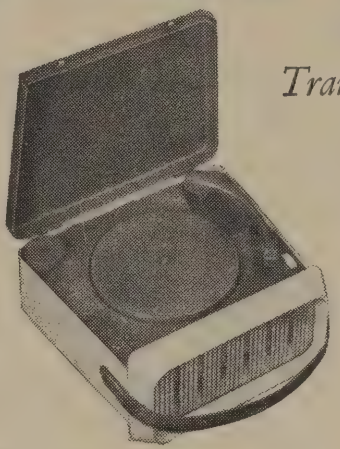
A.—Motor and pickup deck, **39/6.** (2/6 P. & P.)
B.—Ready-built 4-Transistor Amplifier, complete with Volume Control and Loudspeaker. **35/-.** (2/- P.P.).
C.—Portable two-tone case with handle, **5/-.** (2/- P.P.)



The "Minigram"
Transistorised Record Player

- ★ Approximate dimension 9 x 8½ x 4in.
- ★ A real " Family Favourite "
- ★ Ideal for Teenagers
- ★ For use ANYWHERE
- ★ Hours of amusement for the younger members of the family
- ★ Assemble one of these amazing Players in less than 30 mins., supplied in 3 complete units with only 10 connections to make

ONLY 79/6 *The complete PACKAGE* (Plus 5/- P.P.)

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Enormous purchases of Brand New and guaranteed Plessey loudspeakers enable us to offer these units at **THE LOWEST PRICES EVER.** Don't miss this golden opportunity to obtain a first-grade permanent magnet **LOUDSPEAKER** off the production line at **LESS THAN MANUFACTURERS' COST.** Read carefully the prepared list below and choose just the right speaker for the job—**COMPARE THE PRICES ANYWHERE.**

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Diameter in inches	Gauss in Lines	Impedance in Ohms	Price	Diameter in inches	Gauss in Lines	Impedance in Ohms	Price	Diameter in inches	Gauss in Lines	Impedance in Ohms	Price
2	7,000	80	8/-	4	6,000	35	10/6	5	7,500	3	9/-
2½	7,000	35	8/6	4	7,000	35	11/-	5	8,500	5	9/6
2½	7,000	50	8/6	4	9,500	35	11/6	5	9,500	3	10/6
2½	7,000	80	8/-	5	6,000	3	8/-	5	9,500	5	10/6
3½	7,000	35	8/6	5	6,000	5	8/-	6½	7,000	3	11/-
3½	9,500	50	10/6	5	7,000	3	8/6	6½	7,000	5	11/-
4	7,000	25	11/6	5	7,000	5	8/6	6½	8,500	3	11/6

Elliptical Size in Ins.	Gauss in Lines	Impedance in Ohms	Price	Elliptical Size in Ins.	Gauss in Lines	Impedance in Ohms	Price	Elliptical Size in Ins.	Gauss in Lines	Impedance in Ohms	Price
5×3	6,000	3	7/6	5×3	9,000	25	11/-	8×2½	6,000	3	8/6
5×3	7,000	3	8/-	6×4	8,500	3	9/6	8×2½	7,000	5	9/-
5×3	9,000	3	8/6					8×2½	8,500	5	9/6
5×3	9,000	4	8/6	6×4	9,500	3	10/-	8×2½	9,500	3	10/-
5×3	6,000	25	9/6	7×3½	9,500	3	10/6	8×2½	9,500	4	10/-
5×3	7,000	25	10/-								

ALLOW 2/- each speaker for P.P./handling charges, and please specify the exact requirements—the nearest available will be sent.

OVER 50,000 SOLD AND STILL THE DEMAND CONTINUES FOR OUR "HEAVENLY TWINS"

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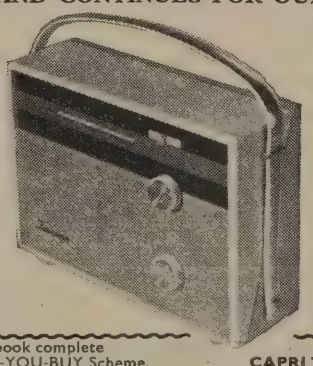
Sensitive !
Super-Selective !
Superb Speaker !

NOW ONLY 79/6 (2/- P. & P.)

ONLY OBTAINABLE HERE
Pocket superhet MW and Droitwich. Size: 4½in. x 2¾in. x 1¼in. Constructional data 1/9 Post free.

The best and easiest transistor build-yourself sets available—send S.A.E. for free Parts List. 6 first-grade Mullard Transistors, Diodes, and all components brand new and guaranteed.



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Queen of them all!

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Portable and car radio
2 waveband Superhet.
Constructional Book, 2/10 post free.

Inclusive price for all associated components, case, and instruction book complete in every detail. Any parts SOLD SEPARATELY on the BUILD-AS-YOU-BUY Scheme.

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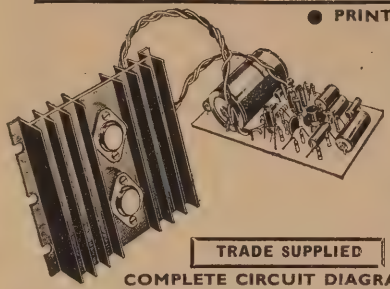
Beautifully geared AM/FM 2-Gang Condensers **4/6**; AM/FM IFT's 465 kc/s and 10.7 Mc/s. **4/6** pair; Magnavox Crystal Tape Recorder Mikes **12/6**; 3 watt Stereo Amplifiers complete ready to switch on, **79/6**; Sentercell rectifiers B3/2D; D3-2-1Y, **2/6** each. **DIODES**—OA70, OA79, OA90, CG46H, GD10, **2/-** each. **TRANSISTORS:** OC45 **4/6**; PXA 101 **3/9**; AF115 **4/6.** SUBMIN **GERMANIUM DIODES 1/3. M.I. DIODES 6d.** each. Silicon Diodes 200 PIV-200 mA. **1/-** each; 400 PIV 330 mA. **2/6** each. Transistor Submin 7 mm. coil set (4) **4/6** per set.

Please send STAMPED AND ADDRESSED envelope with any enquiry. We regret no catalogues—our stocks move too quickly! Kindly make provision for sufficient postage and packing charges to avoid delay. **TERMS:** Cash with order or C.O.D. on orders over 10/-.

10 WATT TRANSISTOR HI-FI EQUIPMENT

● PRINTED CIRCUIT CONSTRUCTION ●



★ **POWER AMPLIFIERS**—Two versions. 6-Transistor and Rectifier on 4 × 2½-inch panels ±1dbB 40 c/s. to 20kc/s. 100mV input for 10 watts with 0.25% distortion at 400 c/s. 60dB feedback. 3 and 15 ohm versions. Low current, only 300mA and 150mA respectively.

● 3 ohm 10 watt ● 15 ohm 10 watt

Built P.P. 2/6 **£5.10.0** Built P.P. 2/6 **£5.19.6**

TRADE SUPPLIED

● Mains units for either of above **69/6** —will run two amplifiers. Either type P.P. 2/6.

COMPLETE CIRCUIT DIAGRAMS FREE ON REQUEST

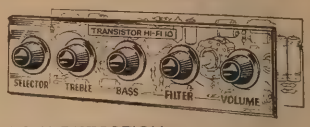
★ **PRE-AMPLIFIER AND CONTROL UNIT.** For use with either of above amplifiers or valve types—Hum-free—2½mA drain—Battery operated or from above mains units—8 inputs between 1.5mV and 300mV—for all pick-ups, microphones, tuners, tape replay, separate treble, bass and volume with cut and boost—4-position low pass filter—40 c/s roll-off, etc. Panel size 9 x 2½".

★ STEREO PRE-AMPLIFIER AND CONTROL UNIT

Developed from mono preamp, with the addition of mono/stereo selector and balance control. Overall size 9 x 3½ x 1½in. Provides 8 inputs per channel, ganged controls, fully equalised inputs. Designed to feed two of above power amplifiers—either type. Battery operated or from mains unit.

PRICE BUILT £10.19.6 P.P. 3/6. ● Dark brown and gold panel plate **12/6.**

PERFORMANCE EQUAL TO VALVE UNITS OF FOUR TIMES THE PRICE AND MANY TIMES THE SIZE.



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- HIGH GAIN
- MAINS OR BATTERY
- LOW NOISE
- MONO OR STEREO

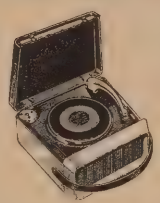
● **PRE-AMPLIFIER** Built **£5.10.0** P.P 2/6

● Dark brown and gold panel plate **8/6** ●

INTEGRATED STEREO PREAMPLIFIER

● **GUARANTEED HIGH PERFORMANCE UNITS — CALL FOR DEMONSTRATION** ●

MINIGRAM TRANSISTOR PORTABLE RECORD PLAYER



● Made by well known British manufacturer. Features ready built 4-transistor printed circuit 1 watt amplifier, elliptical speaker and volume control. Low current. Starr, constant speed 45 r.p.m. turntable with crystal pick-up. Strong moulded two colour cabinet with handle. Plays anywhere on long life 9 volt battery. Requires less than half an hour's work to connect up using ready built units and easy instructions.

TOTAL COST 79/6 P.P. 5/– (Battery 3/9).

Or Amplifier with volume control and 5 x 3-inch Speaker, 4-Transistor, **35/-.** P.P. 2/–.

9 volt Starr Player with Pick-up **39/6.** P.P. 2/6. And Two-Tone Case **5/–.** P.P. 2/–.

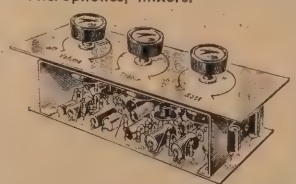
RECORD/REPLAY/ERASE TAPE HEADS

Marriot Type R/RP/3 ¼ track record/replay head and Mullard type TS erase head with mounting post.

Bargain offer **15/- Pair.** P.P. 1/-.

7-TRANSISTOR RECORD/PLAYER/RADIOGRAM AMPLIFIER

- 4 watt peak output.
- Full Treble and Bass boost and cut.
- 40 c/s to 20 kc/s. ±3 dB.
- Inputs for Pick-ups, Radio Tuners, Microphones, mixers.



● **TWO VERSIONS AVAILABLE.**

12/18 volt for 15 ohm speakers (mains unit now **60/-** extra).

9/12 volt for 3 ohm speakers (mains unit **49/6** extra).

● Size only 6 x 2½ x 2in.

Ideal for mains or battery, portable or domestic record player, grams, etc. Or car.

Built Ready To Use £5.19.6 P.P. 2/–.

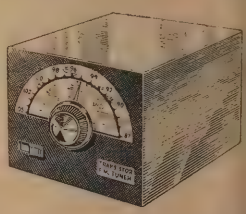
● VHF FM TRANSISTOR TUNER ●

★ **5-Transistor.**

★ **4 Diodes.**

★ **Full coverage 87 to 105 Mc/s.**

★ **AFC and AVC.** Printed circuit design of high sensitivity and quality. Output for valve or transistor amplifiers. Size 3½ x 2½ x 4in. Simplified building instructions. Operates from 9 volts 9/10 mA. All parts sold separately. Complete with dark brown and gold panel plate.



TOTAL COST £7.19.6 P.P. 2/6. (Cabinet assembly 20/- extra)

Detailed Circuit Book on Request.

PORTABLE TRANSISTORISED TEST EQUIPMENT

★ **ALL TRANSISTOR SIGNAL GENERATOR.** 150 kc/s. to 350 mc/s. AF, RF Mod. etc., **£9/10/-** with leads, batt., etc.

★ **TRANSISTORISED RESISTANCE CAPACITANCE BRIDGE.** 1 pF to 100 mfd. 1 ohm to 100 meg., leakage test, visual null indicator. **£8/5/-** with batt.

★ **AUDIO GENERATOR.** 10 to 100,000 c/s Sine/square. **£16/15/–,** with batt.

★ **TRANSISTORISED POWER SUPPLY UNIT.** 1 to 15 v. D.C. up to 0.1 amp. 230/250 v. A.C. mains. **£6/10/–.**

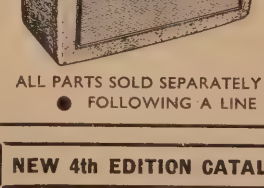
POST and PACKING 2/6 ANY TYPE

● **DETAILED LEAFLETS ON REQUEST** ●

TRANSISTOR INDUCTANCE BRIDGE

Model 66. ½μH to 100H. Fitted edgewise meter, etc. Q and Tan measurements, **£18.0.0.**

NEW! "CONVAIR" PUSH-BUTTON PORTABLE/CAR RADIO



- **New printed circuit 6-Transistor design. Over 700mW push-pull output.**
- **Push-button selection of MW and LW with full tuning on both wavebands.**
- **A new design with amazing performance at a realistic price.**
- **New attractively designed portable cabinet with horizontal tuning and all stations marked.**

Total cost of ALL Parts (Batteries 6/- extra) **£7.19.6** P.P. 3/6.

ALL PARTS SOLD SEPARATELY **(Available June/July)**

● FOLLOWING A LINE OF QUALITY AND VALUE IN PORTABLES ●

NEW 4th EDITION CATALOGUE

86 pages (size 10 x 7½in.), Packed with hundreds of new items. Price reductions. Fully detailed and illustrated. Transistors—Components—Hi-Fi equipment.

2/6 Post Free.

Valves, Crystals, Components, Transistors and Rectifiers are our speciality.

HENRY'S RADIO LTD.

303 EDGWARE ROAD, PADDINGTON, LONDON, W.2.

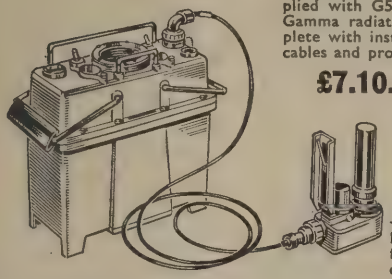
OPEN ALL DAY SATURDAY. **100 yards from Edgware Road Tube Station.**

PADdington 1008/9. OPEN MON. TO SAT. 9-6. THURS. 1 o'clock.

● ***CALL IN AND SEE US — ANY TIME*** ● ***ELECTRONIC COMPONENT SPECIALISTS*** ●

9WW—147 FOR FURTHER DETAILS.

PORTABLE GEIGER COUNTERS FOR MEASUREMENT OF RADIO-ACTIVITY



offered at a fraction of cost ● Supplied with G5H Tube, for testing Gamma radiation. Supplied complete with instructions, haversack, cables and probe.

£7.10.0 p.p. 10/-.

BRAND NEW

M2H Tube for Beta Radiation measurement for liquids 22/6 extra.

★ Plug in EHT unit runs from 1½ volt Penlite cells, 70/-.

QUARTZ CRYSTALS

100 Kc/s.	15/-
500 Kc/s. 2 Pin	15/-
455 Kc/s. (AR88)	12/6
HRO 456 Kc/s.	15/-
5,000 Kc/s. 2 Pin	10/-
10 Mc/s. 2 Pin	15/-
27.255 Mc/s. Radio Control	15/-
HC6U 18 Mc/s. to 46 Mc/s.	7/6

80 frequencies 0.005% Accuracy. Over 600 frequencies in stock. See new crystal lists.

ZENER REFERENCE DIODES

★ IN430 8 to 8.8 volt, 0.2% stability from —55°C to +100°C 45/- each.

★ IN429 5.9 to 6.5 volt, 1% stability from —55°C to +100°C 15/- each.

CATHODEON MINIATURE CRYSTAL OVEN

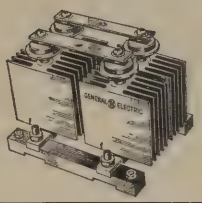
6 or 12 volt A.C./D.C. 80°C. for HC6U or 2M crystals. Brand new, 22/6. P.P. 1/-.

● **GS10CS Dekatron Display Tubes 25/-.** Base 2/-.

● **931A Photomultipliers, 60/-,** with base.

● **89D (CV2193) Double Beam 'Scope Tube 59/6.**

SILICON POWER RECTIFIERS



Made by G.E.C. (U.S.A.). Rated 100PIV 160 amps. Surge 1,800 amps. Bridge connected. Fitted four high temperature silicon rectifiers on finned heat sink as illustrated.

£10 P.P. 5/6.

PLESSEY CASTANET CAPACITORS

Small circular type Single hole mounting. Size ¼ x ⅜in. diameter. Large capacity.

750 mfd. 3 volt	7/6	140 mfd. 30 volt	12/6
250 mfd. 15 volt	10/-	50 mfd 70 volt	7/6

S.T.C. TANTELUM CAPACITORS

67 different types in stock—polarised and non-polarised. Standard and high temperature. Prices from 3/6.

MULTI-RANGE TESTMETERS

★ PT34	1 K ohm/volt	£1	19	6
★ MI	2 ,, ,,	£2	9	6
★ THL33	2 ,, ,,	£3	15	0
★ EP10K	10 ,, ,,	£4	9	6*
★ ITI-2(200H)	20 ,, ,, (illus)	£5	5	0
★ TP55	20 ,, ,,	£5	19	6*
★ EP30K	30 ,, ,,	£6	19	6*
★ 500	30 ,, ,,	£8	19	6*
★ EP50K	50 ,, ,,	£9	19	6

*Leather case available.

See Catalogue for full details.

TRADE ENQUIRIES INVITED ON ALL ITEMS.

MODEL SB305 EDGEWISE METER. 50-0-50μA. 25/-. P.P. 9d.

MAINS AND BATTERY RECORD DECKS

ALL COMPLETE with ARM and CARTRIDGE.

★ BSR UA14 4-speed	£5	19	6
★ BSR UA15 4-speed	£6	19	6
★ Garrard Autoslim 4-speed	£6	10	0
★ Unplugable Head Version or Stereo Version	£6	19	6
	£7	19	6
★ SRP10 4-speed or BSRGU7	£5	5	0
★ Garrard AT6 with Stereo Cartridge, 4-speed	£10	19	6
★ AT6 with Mono head	£10	10	0

P. & P. 3/6 any type above.

★ 9 volt Star, 45 r.p.m.	£1	19	6
★ 45 and 33 r.p.m. Star, 9V	£4	12	6
★ 45 r.p.m. Garrard 6V	£1	15	0
★ 4-speed B.S.R., 9V	£5	5	0

P. & P. 2/6 any of above.

FM VHF TUNING HEART

Printed circuit construction, fully tunable 85 to 105 mc/s. Completely screened. Requires UCC85 (8/6), R.F. stage and osc./mixer stage.

Brand new in maker's cartons 15/-. P.P. 1/-

TRANSISTOR 4-CHANNEL MIXER

Self contained in sprayed metal cabinet. Provides four inputs with control on each channel. Price 59/6.

TRANSISTOR TUNER

Prebuilt medium wave superhet tuner. 3-transistors and detector. 9 volt operated. Price 82/6.

MULLARD POT CORES

LA1	12/6	LA5	17/6	LA45	15/-
LA2	15/-	LA6	22/6	LA2503	15/-
LA3	19/6	LA9	17/6	LA2504	15/-
LA4	12/6	LA10	17/6	LA2505	17/6

QUALITY MICROPHONES

(See new Catalogue for full range)

DF1 50k Dynamic with Stand	£2	12	6
DM304 Stock 50 ohm/50k	£5	5	0
BM3 Crystal with Stand	£2	9	6
MC70 Crystal Studio	£2	19	6
DM16HL Dual impedance	£7	7	0
100C Crystal with Stand	£1	19	6
Adjustable Table Stand (P.P. 3/6)	£1	9	6

SCOTCH BOY TAPE

3½in. L.P. Tape. Complete with spare spool 5/6 P.P. 1/-.

TRANSISTOR PORTABLE WALKIE-TALKIES

9-transistor Portable Trans-receivers. Supplied complete with leather cases, batteries, aerials, etc. in presentation case. Range up to 5 miles in favourable conditions. Sizes 6½ x 3 x 1½ inches. Superhet crystal controlled on transmit and receive.

Price **£25 Per Pair.** P.P. 3/6.

MARTIN AUDIO KITS

Unit 1. 5-Stage Inputs	47/6
Unit 2. Pre-amplifier	37/6
Unit 3. 3-Channel Mixer	79/6
Unit 4. Tone Control Unit	62/6
Unit 5. 10-Watt Amplifier	£5/12/6
Unit 6. Mains Unit	52/6

Inter-Connecting Units designed to construct all Transistor Audio Equipment. Leaflets on request.

★ Sinclair Micro-6	59/6
★ Sinclair Micro Injector	27/6
Tape Jack Tuner	29/6
10-Watt Horn Tweeter	29/6
20-Watt Super Tweeter	69/6
Two-channel Mixer	19/6
1 to 200 Mc/s. F/str. Meter	69/6
★ ¾-Watt 4-transistor 9 v. 3 ohm	49/6
5-hole Chassis Punch Kit	49/6
Headphones 2K ohm 12/6; 4K ohm	14/6
Stereo Headphones	3 gns.
Stereo Stethoscope Headset	25/-
Resistor Substitution Box	37/6
Crystal Mono Stethoscope Headset	10/6
Magnetic Mono Stethoscope Headset	12/6
Transistor Signal Injector	39/6
Fully Disappearing Car Aerial	35/-
Test Lead Kit with Pouch	8/6
Capacitor Substitution Box	29/6
De Luxe Stereo Headsets with junction box	£6

GARRARD 2-TRACK BATTERY TAPE DECK

9 volt operated, 2 track, 2 speed. Brand new, fitted heads, etc. Supplied complete with cassette. Brand New.

£11/15/-. P.P. 3/6.

METER BARGAINS

50 Microamp 2½in. square MC	35/-
0/100μA 2½in. f. D.C.	35/-
1 mA 2½in. flush round	30/-
0/500μA. 2in.	15/-
0/500μA. 2½in. flush mounting, D.C.	20/-
2½-0-2½ mA., 2½in. flush. D.C.	12/6
0/15 volt M.I. 2½in. FR. A.C.	8/6

MINIATURE PANEL METERS

*0/50μA (D.C.) 39/6. *0/5mA (D.C.) 27/6
*0/500μA (D.C.) 32/6. *0/300V (D.C.) 27/6
*0/1 mA (D.C.) 27/6. "S" Meter 35/-
All Brand New Boxed.

*Available Clear Plastic Front or Black Moulded. State which.

AMERICAN SILICON RECTIFIERS

TJ40 (IN 3075) 200 PIV 200 mA	3/6
IN253 100 PIV 3 amp	10/-
TM41 400 PIV 3 amp	10/-
TM64 600 PIV 3 amp	17/6
IN249 100 PIV 20 amp	35/-
IN1186 200 PIV 35 amp	45/-
45L 50 PIV 110 amp	75/-
70U 50 PIV 250 amp.	85/-

BY100 6/6; BYZ13 10/-; GJ3M 4/-.

BRAND NEW

FROM STOCK 150 TYPES OF TRANSISTORS AND RECTIFIERS.

SEE LATEST CATALOGUE

2/6 Post Free.

Henry's Radio Ltd.

303 EDGWARE ROAD, LONDON, W.2.

PADdington 1008/9

Open Monday to Sat. 9-6. Thurs. 1 o'clock.

CLEAR PLASTIC PANEL METERS

First grade quality, Moving Coil panel meters, available ex-stock. S.A.E. for illustrated leaflet. Discounts for quantity. Available as follows.

Type MR.38F. 1 21/32in. square fronts.

50μA.....	32/6	1A D.C. ..	22/6
100μA.....	29/6	5A D.C. ..	22/6
200μA.....	27/6	3V D.C. ..	22/6
500μA.....	25/-	10V D.C. ..	22/6
50-0-50μA ..	29/6	50V D.C. ..	22/6
100-0-100μA	27/6	100V D.C...	22/6
1mA	22/6	150V D.C...	22/6
5 mA	22/6	300V D.C...	22/6
10mA	22/6	500V D.C...	22/6
50mA	22/6	750V D.C...	22/6
100mA	22/6	15V A.C. ..	22/6
150mA	22/6	50V A.C. ..	22/6
200mA	22/6	150V A.C...	22/6
300mA	22/6	300V A.C...	22/6
500mA	22/6	500V A.C...	22/6
750mA	22/6		

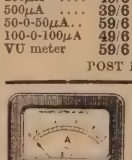
Type MR.52P. 2½in. square fronts.

50μA	57/6	10mA	32/6
100μA	47/6	100mA	32/6
500μA	37/6	1A D.C. ..	32/6
50-0-50μA..	57/6	300V D.C...	32/6
100-0-100μA	47/6	300V A.C...	32/6
1mA	32/6		

Type MR.65P 3⅜ × 3½in. fronts

50μA	59/6	1mA	35/-
100μA	49/6	10mA	35/-
500μA	39/6	100mA	35/-
50-0-50μA..	59/6	1A D.C. ..	35/-
100-0-100μA	49/6	300V D.C...	35/-
VU meter	59/6	300V A.C...	35/-

POST EXTRA.



BAKELITE PANEL METERS

First grade quality. 3½in. square fronts.

25μA	65/-	1A D.C. ..	29/6
50μA	42/6	5A D.C. ..	29/6
100μA	39/6	*1A A.C. ..	29/6
500μA	35/-	*5A A.C. ..	29/6
50-0-50μA ..	42/6	*30A A.C. ..	29/6
100-0-100μA	39/6	300V D.C...	29/6
1mA	29/6	*300V A.C.	29/6
10mA	29/6	300V A.C...	35/-
100mA	29/6	VU Meter ..	49/6

*Moving iron, all others moving coil.
POST EXTRA.

ILLUMINATED "S" METER

1 21/32in. sq. front. Cal. in 8 units. 6V lamp **29/6**. P.P. 1/-. Ditto 2⅝in. square **39/6**. P.P. 1/-.

MORE METER BARGAINS

100μA 2½in. Flush rd.	42/6
30-0-30 mA 2½in. Flush rd.	9/6
300V A.C. 2½in. Flush rd.	25/-
500V A.C. 2½in. Flush rd.	25/-
1mA Meter Rectifiers	8/6

Post Extra.

6in. PANEL METERS

Flush panel mounting, hermetically sealed. 300A D.C. m/c. **65/-**. Post 5/-.

WESTON S54 MOVING COIL RELAYS

Brand new boxed **42/6**. P.P. 2/-.

E.M.I. WM.5A CONSUL OSCILLOSCOPES

Available as new, guaranteed perfect condition. **£65** each.

TELEPHONES TYPE H

Sound powered, generator bell ringing, 2 line connection. Fully tested. **£4/19/6**. pr. Carr. 5/-.

MODEL ITI-2 MULTITESTER 20,000 O.P.V.

20,000 O.P.V. D.C.; 10,000 O.P.V. A.C. Specifications: D.C. V.: 0-5-25-250-500-2500 V. A.C. V: 0-10-50-500-1000V. Current: 0-50μA-25 mA.-250 mA. Resistance: 0-60K-6MΩ. Capacity: 0.01-0.3μFd (at A.C. 10 V.) Decibel: −20db- +22db. Output range: 0-10-50-500-1000V. Battery: 1.5 V. U12. SIZE: 3¼in. × 4¾in. × 1¼in. Supplied complete with batteries, leads, instructions, **32/6**. Post 2/6.

HE-40 DE LUXE 4-BAND COMMUNICATION RECEIVER

Frequency coverage 550 kc/s. to 30 mc/s. continuous. Operation 220/240 v. A.C./D.C. The perfect receiver for short wave listening. Special features include: Slide rule tuning dial—electrical bandspread—0-100 logging scale—improved selectivity—Built in "S" meter—A.V.C.—Noise limiter—B.F.O.—'Phone jack—Built in 5in. speaker—tone control—standby switch—supplied with three aerials, ferrite loop for broadcast band, adjustable 58in. whip for short wave and wire aerial. Smartly styled durable metal cabinet. Supplied brand new and guaranteed with manual. **£24/15/-**, carriage paid. S.A.E. for full details. Part exchanges welcome.

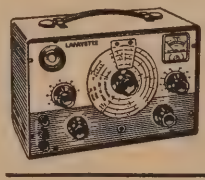
LAFAYETTE HI-FI STEREO HEADPHONES

★ **Air cushioned headband** ★ **Soft rubber ear pads.** ★ **Frequency response,** 25 to 15,000 cycles. ★ **High sensitivity.** Impedance 8 ohms per phone. Supplied complete with all cables, wires, overload junction box and 3-connection plug. **89/6**. P. & P. 2/6.

TS-76 20,000 O.P.V. PUSH BUTTON MULTI-TESTER

Large clear plastic scale, simple operation. D.C. volts up to 1,000 v. A.C. volts up to 1,000 V. Resistance up to 10 megohm. Current up to 250 mA. Decibels −20 to +36 db. Size 6in. × 4⅜in. × 2¼in. Complete with leads, batteries and instructions. **£5/19/6**. P. & P. 2/-.

TE-46 CAPACITY-RESISTANCE ANALYSER



★ Factory wired and tested. ★ Capacitance bridge circuit. ★ Direct reading scales for capacitance and resistance. ★ Magic eye null indicator and meter. ★ Checks opens, shorts, leakage and intermittents. ★ Determines power factor of electrolytics. ★ 2 Turns ratio scales. ★ Measures impedance. Capacity 4 ranges 2PF—2,000 MFD. Resistance 4 ranges 2 ohms-200 megohms. Turns/ratio/inupedance 2 ranges 10 : 1 and 200 : 1. Read insulation resistance direct on meter to 200 meg. Size 10½in. × 7in. × 5¾in. Operation 200/240 v. A.C. Supplied brand new with instructions, **£15**. Carr. 7/6.

TE-20 RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120kc.-260mc/s on 6 bands. Directly calibrated. Variable R.F. attenuator. Operation 200/240 v. A.C. Similar in appearance to TE-46 CR Bridge. Brand new with instructions, **£12**. Carr. 5/-. S.A.E. FOR DETAILS.

NATIONAL H.R.O. RECEIVERS

SENIOR MODEL. Complete with a full set of 9 coils covering 50kc/s to 30mc/s. Each receiver thoroughly checked and tested before despatch. Dual purpose rack model for table or 19in. rack mounting. Extremely good used condition, **£18/18/-**. Carr. £1. 200/250 volt A.C. power supplies for H.R.O. also sold separately, **59/6**. Carr. 5/-. S.A.E. for full details.

ERSKINE TYPE 13 DOUBLE BEAM OSCILLOSCOPE

Time base 2 c/s-750 kc/s. Calibrators at 100 kc/s and 1 mc/s. Separate Y1 and Y2 amplifiers up to 5.5 mc/s. Operation 110/230 volt A.C. Supplied in perfect working order. **£27/10/-**. Carriage 20/-.

MICROAMMETERS

0-500 microamp., 2½in. circular flush panel mounting. Dials engraved 0-15, 0-600 volts. Brand new boxed, **15/-**. P. & P. 1/6.

MINIFLUX ¼-TRACK TAPE HEADS

Set of three, record, playback, erase. Only **29/6** set. P.P. 9d.

FIELD STRENGTH METERS

Frequency coverage 1 to 250 mc/s. Fitted with 200 microamp. meter. Supplied with telescopic aerial, earpiece and instructions, **69/6** post paid.

FIELD TELEPHONES

Type "L" 2 line connection, generator bell ringing. Complete telephone intercom. Supplied in excellent condition, fully tested and complete with batteries. only **69/6** per pair. Carr. 5/-.
Type "F" As above but moulded bakelite case (as illustrated). Supplied complete with wooden transit case for field use. **£4/19/6** per pair. Carr. 5/-.

MODEL 500 30,000 O.P.V. TEST METER

Reads voltages up to 1,000 D.C. at 30,000 ohms per volt and A.C. at 15,000 o.p.v.; D.C. current to 12 amps. Resistance to 60 Megs.; Decibels from −20 to +56; Incorporates internal buzzer for audible warning of direct shorts and blocking condenser for A.F. output measurements. Size 3⅞in. × 6⅜in. × 2¾in.
PRICE **£8/17/6**.

MINE DETECTOR No. 4A

Will detect all types of metals. Fully portable. Complete with instructions. **39/6** each. Carr. 10/-. Battery **8/6** extra.

MAINS RECORD PLAYERS AND AUTO-CHANGERS

ALL GUARANTEED WITH ARM AND CARTRIDGE

Garrard SPR-10 player	£4	17	6
Garrard Autoslim changer..	£6	9	6
Garrard Autoslim de luxe..	£6	19	6
Garrard AT6 changer, mono	£10	9	6
Garrard AT6 changer, stereo	£10	19	6
Garrard 4 H/F mono	£14	19	6
Garrard 4 H/F, stereo	£15	15	0
Garrard Type A changer ..	£17	15	0
Garrard 301 Strobo, no arm	£19	10	0
B.S.R. GU7 single player ..	£4	7	6
B.S.R. UA14 changer	£5	19	6
B.S.R. UA 16 changer	£6	12	6

Postage extra.

SEMI-AUTOMATIC "BUG"

Super speed key. 7 speed adjustments. 10WPM to as high as desired. Weight scale for reproducible settings. Precision tooled, anti-rust nickel plated brass and stainless steel operating parts. Size 6⅜in. × 3in. × 2¼in. Brand New. **£4/12/6**. Post Paid.

SILICON RECTIFIERS

400 v. P.I.V. 4.7 amp. (SCR)	7/6
400 v. P.I.V. 3 amp	7/6
200 v. P.I.V. 6 amp.	5/6
1,000 v. P.I.V. 650mA. ..	7/6
800 v. P.I.V. 500mA.	5/6
400 v. P.I.V. 500 mA.	3/6
200 v. P.I.V. 200 mA.....	3/-
95 v. P.I.V. 3 amp.	5/6
70 v. P.I.V. 1 amp.	3/6
150 v. P.I.V. 165mA.	1/-

Discounts for quantities. Post extra.

PLUGS AND SOCKETS

Painton 15 pin in line printed circuit connectors. **7/6** pr. Large quantities available. Ditto 32 pin, **12/6** pr.
UNITERS. 4 pin, **2/6** pr.; 8 pin **3/6** pr.; 12 pin **4/-** pr.; 18 pin **4/6** pr.
PAINTON MINIATURE JONES. 4 pin **3/6** pr.; 6 pin **4/-** pr.; 8 pin **4/6** pr.; 18pin **7/6** pr.; 24 pin **10/6** pr.; 33 pin **12/6** pr. Post extra.

AMERICAN BLOCK PAPER CONDENSERS

Very high quality. 10 mfd. 600 v. **8/6**; 10 mfd. 1kV **10/6**; 12 mfd. 1.5 kV. **15/-**; post extra.

L.T. METAL RECTIFIERS

FULL wave bridge connected.

12/18V 1A ..	3/9	24/36V 1A ..	7/3
12/18V 2A..	6/3	24/36V 2A..	13/6
12/18V 4A..	8/6	24/36V 15A	45/-
12/18V 6A..	12/3	36/48V 6A..	32/6
12/18V 10A	22/6	Post extra.	

L.T. TRANSFORMERS

For chargers, models, etc. All primaries tapped 200/250V.

(1) 3.5, 9 or 17V. 1 amp.	9/9
(2) Ditto 2A	14/3
(3) Ditto 4A	16/6
(4) Ditto 6A	26/-
(5) 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30V. 2 amp.	18/6
(6) Ditto 4A	30/-
(7) Ditto 5A	37/6
(8) 50V. ½ amp.	13/6
(9) 50V. 1 amp.	15/6

Post extra.

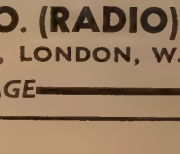
AUTO TRANSFORMERS

Step up or step down. Tapped 0/115/200/230/250V. 20W. **9/-**; 60W. **12/6**; 75W. **15/6**; 150W. **18/6**; 200W. **27/6**; 300W. **42/6**; 500W. **67/6**; 1,000W. **90/-**; 1,500W. **£6/19/6**; 3,000W.* **£7/10/-**; 7,500W.* **£15**.
(*Only tapped 0/110/230V.) Post extra.

12 VOLT A.C. TIME SWITCH

Vernier 0-14 hrs. 250 v. 5A. switch. **17/6**, post 2/-. Suitable 230/12V. transformer **5/9**.

MODEL PT-34 1,000 O.P.V. MULTI-TESTER



Dependable and Easy to Read. ●SPECIFICATIONS: D.C. V.: 0-10-50-250-500-1,000 V. A.C. V.: 0-10-50-250-500-1,000 V. Current: 0-1-100-500 mA. Resistance: 0-100 KΩ. Battery: 1.5 V. U12. Size: 3⅛in. × 2⅝in. × 1⅛in. Supplied complete with batteries, leads, instructions, **39/6**, post 1/6.

SINCLAIR RADIO KITS

MICRO 6. World's Smallest Radio	59/6
SLIMLINE Pocket Radio	49/6
MICRO AMPLIFIER	28/6
SIGNAL INJECTOR	27/6

All above post paid.

G. W. SMITH & CO. (RADIO) LTD.

3 & 34 LISLE STREET, LONDON, W.C.2.

SEE OPPOSITE PAGE →

CONSTANT VOLTAGE TRANSFORMERS

95/130V. input 115V. output 500 watts. Can be used in series for 230V. £4 each. Carr. 10/-.

VARIABLE VOLTAGE TRANSFORMERS

Pri. 230V. Sec. 0-260V. 1 amp £4/10/-; 2½ amp £5/17/6; 5 amp £9; 8 amp £14/10/-; 10 amp £16/10/-; 12 amp £18.15/-; 20 amp £32/10/-. All fully shrouded.

DUMONT KI05IPI DOUBLE BEAM C.R.T.

Twin gun, 6.3V. New, boxed, 59/6. P.P. 3/6.

MAINS ISOLATION TRANSFORMERS

230V. to 230V. 50W. 16/6. P.P. 3/-; 100W. 29/6. P.P. 3/6; 1,000W. £5. Carr. 10/-.

TM-59'er "S" METER

Signal strength meter using VTVM principles. Calibrated in S units. Sensitivity and zero adjustments. For any superhet receiver with AVC. Requires 150/200V. and 6 or 12V. Complete with valve and full instructions. 82/6. P.P. 2/6.

VARIAC TRANSFORMER

24 amp. Pri. 230V. Sec. 185/250V. £12/10/-. Carr. 10/-.

MAINS MOTORS 220/240V.

90 watts, 5,000 r.p.m. 4¾ × 3in. ¼in. spindle. 22/6. P.P. 2/-.

MINIATURE LEAD ACID ACCUMULATORS

Brand new 2V. 1.5A. 4 × 1 × 1¾in. 5/6. P.P. 1/3. 12V. 0.75A. 4 × 3 × 1¾in. 15/6. P.P. 1/6.

TWIN MOTOR BARGAIN

200/250V A.C. Twin concentric spindles. Either motor reversible. 1,400 r.p.m. Brand new 12/6. P.P. 2/6.

DESK TELEPHONES

8td. type with handset and bell. No dial. Unused 25/-. P.P. 3/6.

GEARED SLIDER RHEOSTAT

1.2 ohms 12 amps. 15/6. P.P. 3/6.

COLLARO/MAGNAVOX STUDIO TAPE TRANSCRIPTOR

Brand new, 3 speeds, 1⅞, 3¾, 7½ i.p.s. 3 motors, digital counter. Complete with 2 spools, instructions, 10 gns. Carr. paid.

4-CHANNEL TRANSISTORISED MICROPHONE MIXER

Add musical highlights and additional sound effects to your recordings. The MM-4 permits mixing of four signals such as microphone, records, tuner, etc. into single output. Inputs and output take standard plugs. Fully transistorised and self-contained in handsome case. PRICE 59/6 Post Paid.

R.C.A. HEADSETS

Low imp. Fitted with std. jack plug, 15/6. P.P. 1/6.

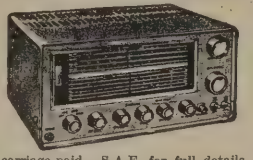
LARGEST STOCKS OF COMPONENTS, RECEIVERS AND TEST EQUIPMENT IN THE COUNTRY

Send 1/- P.O. for full catalogue and lists.

OPEN 9 a.m. to 6 p.m. every day MONDAY TO SATURDAY

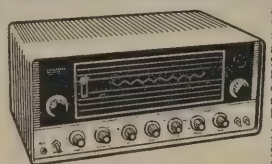
Trade supplied

HE-30 SUPER AMATEUR COMMUNICATION RECEIVER



4 bands covering 550 kc/s. to 30 mc/s. continuous. Operation 200/240 volts A.C. Special features include: Easy-to-read illuminated slide rule dial—built-in Q multiplier — Aerial trimmer — calibrated electrical bandspread on amateur bands. —0-100 logging scale — noise limiter — AVC/MVC selector—stable oscillator and B.F.O. for clear CW and SSb. reception—built-in edgewise "S" meter. Output for 'phones or STD. speaker. Supplied brand new and guaranteed with manual. £42 carriage paid. S.A.E. for full details. Part Exchanges welcome.

HE-80 14-VALVE AMATEUR COMMUNICATION RECEIVER



550kc/s. to 30mc/s + 2 METRE BAND 144 to 146 mc/s. Two receivers in one. Continuous coverage from 550kc/s to 30mc/s and 144 to 146mc/s. Dual conversion on 2 metres, with extra RF and Mix. stage. Special features include "S" meter, Crystal calibrator "Q" multiplier, B.F.O., Bandspread on all amateur bands, large illuminated dial with logging scale. Improved A.N.L. Regulated power pack. Output for phones or speaker (8 or 500 ohms). Operation 200/250 volt A.C. Valve line-up 4 × 6AQ8, 3 × 6BA6, 2 × 6BE6, 1 × 6BL8, 6AL5, 6AQ5, 6CA4, and OA2. Attractive grey steel cabinet, 17 × 7½ × 10in. Supplied brand new and guaranteed complete with instruction manual. 59 GNS. Carriage paid. S.A.E. for full details. Part exchanges welcome.

NEW MINISTRY RELEASE MODERN ARMY R.216 AM/FM V.H.F. RECEIVER

BRAND NEW 5 BAND—16 VALVE RECEIVER COVERING 19-157 mc/s. CONTINUOUS. An extremely well made receiver using miniature valves and components, pan-climatic and hermetically sealed. Special features include:—8 FT film dial on each band, 2 R.F. and 4 I.F. stages (4.86 mc/s), B.F.O., N.L., crystal calibrator at 1 mc/s. and 5 mc/s., bandwidth 50 kc/s or 120 kc/s, I.F. output, 600 ohms output or 150 ohms phone output. Size 12½ × 9 × 8½in. Supplied complete with separate power unit and connecting cable for operation on 0/110/200/250 volt A.C. Price £29/10/- complete. Carriage 30/-. S.A.E. for details. Circuit diagram supplied.

MODEL TE-18 GRID DIP METER

COMPLETE WITH ALL COILS FOR ALL FREQUENCY RANGES FROM 360 Kc/s to 220 Mc/s.

● Compact—True one handed operation. ● Covers 360 kc/s. to 220 mc/s. ● Functions as a Grid Dip Oscillator. Absorption wave meter and Oscillating Detector. ● Completely wired—not a kit. The TE-18 can determine the resonant frequencies of tuned circuits, detect stray resonances in transmitters, check neutralization, etc. Frequency range 360 kc/s. to 220 mc/s. in 8 accurately calibrated ranges. Grid current meter has a 500 μA movement. Uses a 6AF4A valve, powered by a built-in transformer-operated power supply with selenium rectifier. For 220/240 v. A.C. 50-60 c/s. Size 7½in. H. × 9½in. W. × 2in. D. £12/10/-. Carr. 3/6.

MODEL PV-58 VACUUM TUBE VOLTMETERS

Latest design with special circuit for stable and accurate measurements. Resistors used are all within 1% tolerance. Special designed 4in. 200μA meter. 11 meg. inputs.

Ranges: —D.C.V. 0-1.5-5-15-50-150-500-1,500 V.

+D.C.V. 0-1.5-5-15-50-150-500-1,500 V.

A.C.V. 0-1.5-5-15-50-150-500-1,500 V.

R.M.S. 0-1.4-4-14-40-140-400-1,400-4,000 P.P.

Resistance: 2 ohm to 1,000 meghom.

Decibels: —10db to +65db.

Operation: 220/240 volt A.C. Size 7 × 4½ × 4in. Supplied brand new and guaranteed complete with probe and instructions. £13/19/6. P.P. 3/6.

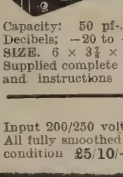
PRECISION COMBINATION VOLTMETER/AMMETER

Two separate instruments housed in polished wood case, 6in. scales with knife edge pointers. Ranges as follows: A.C. and D.C. Volts 0-160-300-600 volts. A.C. and D.C. Current: 0-25-50-150-200 amps. Supplied complete with shunts, leads and leather carrying case. Brand new condition. £9/19/6 each. Carr. 7/6.

PRECISION PORTABLE VOLTMETERS

Polished wood case. 8in. scale with knife edge pointer. A.C. and D.C. volts. 0-160 volts, 59/6; 0-160-320 volts £5/19/6. PP. 3/6.

TE-12 20 000 O.P.V. MULTIMETER



High quality multimeter, rugged design and wide ranges.

D.C. Volts: 0-0.6-6-30-120-600-1,200-3,000-6,000 v.

A.C. Volts: 0-6-30-120-600-1,200 v.

D.C. current; 0-0.06-6-60-600 mA.

Resistance; 0-6K-600K-6 meg.-60 meg.

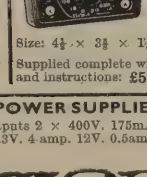
Capacity: 50 pf.-2 mfd.

Decibels; —20 to +63 db.

SIZE. 6 × 3½ × 1¾in.

Supplied complete with test leads, battery and instructions £5/19/6. Post 2/-.

NH-201 30,000 O.P.V. MULTIMETER



High quality, high sensitivity multimeter.

D.C. volts: 0-0.25-1-10-50-250-500-1,000

A.C. volts: 0-10-50-250-500 v.

D.C. current: 0-50 μA-10-250 mA.

Resistance: 0-5K-500K-5 meg.

Decibels: —10 to + 22 db.

Size: 4½ × 3½ × 1¼in.

Supplied complete with test leads, battery and instructions: £5/10/-, post 2/-.

HEAVY DUTY POWER SUPPLIES

Input 200/250 volt A.C. Three H.T. outputs 2 × 400V. 175mA. and 350V. 225mA. All fully smoothed. 2 × 6.3V. 5 amp., 6.3V. 4 amp. 12V. 0.5amp. Supplied in perfect condition £5/10/-. Carr. 20/-.

MARCONI TF 144G/4 STANDARD SIGNAL GENERATORS

First release of this late mark. 85 kc/s to 25 mc/s ±1%. Output variable from 1μV. to 1 volt. Internal sine wave. modulation 400 c/s up to 75% depth Operation 200/250 volt A.C. Offered in really excellent condition, like new, fully tested and guaranteed, £25. Carr. 30/-.

LAFAYETTE BRAND RECORDING TAPES

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities.

3in.	200ft. L.P. mylar	4/-
3½in.	600ft. T.P. mylar	10/-
5in.	600ft. std. plastic	8/6
5in.	900ft. L.P. acetate	10/-
5in.	1,200ft. D.P. mylar	15/-
5½in.	1,200ft. L.P. acetate	12/6
5½in.	1,800ft. D.P. mylar	22/6
7in.	1,200ft. std. mylar	12/6
7in.	1,800ft. L.P. acetate	15/-
7in.	1,800ft. L.P. mylar	20/-
7in.	2,400ft. D.P. mylar	25/-

Postage 2/-. Over £3 post paid.

MARCONI TF-885 VIDEO OSCILLATORS

20 c/s to 5 mc/s sinewave and 500 c/s-150 kc/s squarewave. Eleven position attenuation. Operation 110/200/250 volts A.C. Supplied in perfect condition, £45. Carriage 30/-.

TRANSISTORISED FIELD STRENGTH METER

3 bands 2.5 to 57 mc/s, permits easy tune up for max. transmitter output. Earphone jack to monitor audio. 200μA meter cal. 0-10. Supplied complete with battery, telescopic aerial, £7/7/- each. P.P. 2/6.

HEADSET AND BOOM MICROPHONE

American type, low impedance, padded, 49/6. P.P. 2/6.

ROTARY TRANSFORMERS

12 VDC input. Output 310/360VDC. 30mA. New boxed, 10/-. P.P. 2/-.

200KΩ INSTRUMENT POTS

Wirewound, 3½in. dia., 5/6 ea. P.P. 1/3

PHOTO VOLTAGE AMPLIFIER UNITS

Fitted with twin selenium photo cells, Tinsley mirror galvo, £9/19/6 each. Carr. 7/6.

500 VOLT BRIDGE MEGGERS

Evershed Vignoles Series II. Supplied in as new condition, complete with leather case, £40 each. Guaranteed.

NOMBREX INSTRUMENTS

1. Transistorised audio generator. 10-100,000 c/s. Sine or square wave. Post paid with battery £16 15 0
2. Transistorised Signal Generator. 150 kc/s-350 Mc/s. Better than 2%. Post paid with battery £9 10 0
3. Transistorised Resistance Capacity Bridge, 1Ω-100 megΩ, 1 pf.-100μf. Leakage test and visual null indicator. Post paid with batt. £8 5 0
4. Mains operated transistor power supply unit. Regulated output 1-15 v. up to 100 mA. Overload protection. Post paid £6 10 0
5. Transistorised Inducation Bridge 1μH to 100H..... £18 0 0

S.A.E. for full details.

9 TRANSISTOR WALKIE-TALKIE TWO-WAY RADIO

Average range up to 1.5 miles. Supplied complete with Telescopic Aerials, Batteries, Personal Earpieces, Leather carrying cases and instructions. Brand new guaranteed, £25 pair. S.A.E. for details.

G.W. SMITH & CO (RADIO) LIMITED
Phone: GERRARD 8204/9155
Cables SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

Portable Transistor Sets

Backed by Super After-Sales Service

POCKET FIVE

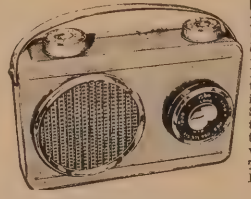
★ 7 Stages—5 transistors and 2 diodes.

Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 2½in. moving coil speaker, built into attractive black case with red speaker grille. Size 5½ × 1½ × 3½in. (Uses 1289 battery available anywhere.)

Total cost of all parts now only **42/6** P. & P. 3/-.

Parts price list and easy build plans 1/6.

ROAMER SIX



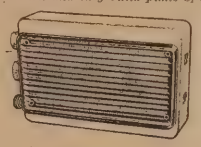
FREE! *Miniature Earpiece, plug and socket (value* 9/6*) and details of conversion to private listening.*

★ 8 stages—6 transistors and 2 diodes. Listen to stations half a world away with this 5 waveband portable. Tunable on Medium and Long waves, Trawler Band and two Short waves. Sensitive ferrite rod aerial and telescopic aerial for short waves. Top grade transistors, 3-inch speaker, handsome case with gilt fittings. Size 6½ × 4½ × 1½in.

Total cost of all parts now only **£4.19.6** P. & P. 3/6.

Parts price list and easy build plans 3/-.

TRANSONA FIVE

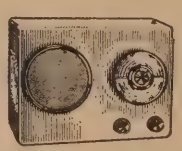


★ 7 Stages—5 transistors and 2 diodes. Covers M. and L. Waves and Trawler Bands, a feature usually found in only the most expensive radios. On Test Home, Light, 208, and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and new type fine tone super dynamic 2½in. speaker, attractive case in grey plastic with red grille. Size 6½ × 4½ × 1½in. approx. (Uses 1289 battery available anywhere)

Total cost of all parts. NOW ONLY **42/6** P. & P. 3/6.

Parts price list and easy build plans 2/-.

SUPER SEVEN



★ 9 Stages—7 transistors and 2 diodes

Covers M. and L. Waves and Trawler Bands. Completely portable—built-in ferrite rod aerial for wonderful reception. Push-pull output, 3in. speaker (will drive larger speaker). Size 7½ × 5½ × 1½in. (Uses 9v. battery, available anywhere.) (Telescopic aerial for Trawler Band optional extra 6/11.)

Total cost of all parts now only **£3.19.6** P. & P. 3/6.

Parts price list and easy build plans 2/-.

TRANSONA SIX *NEW!!*

★ 8 stages—6 transistors and 2 diodes. A top performance receiver covering full M. & L. Waves and Trawler Bands. High-grade powerful magnet 3in. speaker makes listening a pleasure. Push-pull transformers for ample power. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6½ × 4½ × 1½in. (Carrying Strap 2/- extra.) (Uses PP4 battery available anywhere.)

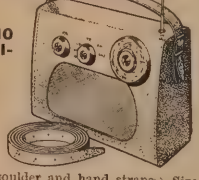
Total cost of all parts **59/6** P. & P. 3/6.

Parts price list and easy build plans 1/6.

MELODY SIX *NEW!!*

★ 8 stages—6 transistors and 2 diodes. Our latest completely portable transistor radio covering M. and L. waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208, and many Continental stations. Handsome leather look pocket size case, only 6½ × 3½ × 1½in. approx. with gilt speaker grille and hand and shoulder straps. *Parts price list and easy build plans* 2/-. **Total cost of all parts** **£4.9.6** P. & P. 3

ROAMER SEVEN Mk. III



5 WAVEBAND PORTABLE OR CAR RADIO AMAZING PERFORMANCE AND SPECIFICATION.

★ 9 stages—7 transistors and 2 diodes. Covers M. and L. Waves, Trawler Band and two Short Waves to approx. 17 metres. Push-pull output for room-filling volume from rich toned heavy duty 5in. speaker. Air spaced ganged tuning condenser. Ferrite rod aerial for M. & L. Waves and telescopic aerial for S. Waves. Simulated hide case with gilt trim and shoulder and hand straps. Size 9 × 7 × 4in. approx. The perfect portable and the ideal car radio. (Uses PP9 battery available anywhere.)

Total cost of all parts NOW ONLY **£5.19.6** P. & P. 5/6.

Parts price list and easy build plans 3/-.

All components used in our receivers may be purchased separately if desired. Parts price lists and easy build plans supplied free with sets of parts or available separately at prices stated. *OVERSEAS POST* 10/-.

RADIO EXCHANGE

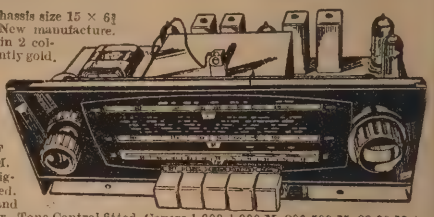
61 HIGH STREET, BEDFORD Phone 2367

Callers side entrance Barratts Shoe Shop

Weekdays 9-5 p.m. Sats. 9-12.30

9WW—151 FOR FURTHER DETAILS.

BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £13.13.0 (CARRIAGE PAID)



A.C. ONLY. Chassis size 15 × 6½ × 5½in. high. New manufacture. Dial 14½ × 4in., in 2 colours, predominantly gold. Pick-up, Extension Speaker. Ae., E., and Dipole Sockets. Five "piano" push buttons — OFF L.W., M.W., F.M. and Gram. Aligned and tested. With all valves and O.P. Transformer. Tone Control fitted. Covers 1,000-1,900 M; 200-500 M; 88-98 Mc/s Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. Speaker and Cabinet to fit chassis (table model), **47/6** (post 5/-). 10 × 6in. ELLIPTICAL SPEAKER **25/-** to purchasers of this chassis.

TERMS: (Chassis) **£3/10/-** down and 5 monthly payments of **£2/4/-** or with Cabinet and Speaker **£4** down and 6 monthly payments of **£2/4/-**.

ALTERNATIVE DESIGN. LW 1,000-2,000M; SW (9-15 mc/s); MW 190—475M VHF 87-100 mc/s; gram position. Dial dark brown and gold. Otherwise similar to above chassis. Price **£15/15/-** (carr. paid), terms **£3/10/-** down and 6 monthly payments of **£2/4/-**.

HIGH QUALITY PUSH-PULL OUTPUT AMPLIFIER

Chassis 10in. × 7½in. × 7½in. high over trans. Used, guaranteed and in excellent order. New valves EZ40, ECC83 and 2 × EL41; 8 watts. Mains trans. tapped 200-250 volts. O.P. Trans. for 3, 8 and 15 ohm. Choke smoothing. On-Off/Vol. and tone controls. For tuners, Record Players, etc., **£3/15/-** (P. & P. 6/-). We can modify for Guitar input for **15/-** extra.

BATTERY ELIMINATOR

For 4 low consumption valves (96 range), 90 v. 15 mA. and 1.4 v. 125 mA., **45/** (4/- post). 200-250 v. A.C. Also for 250 mA. 1.4 v. and 90 v. 15 mA. at same price Two units to replace existing batteries.

TERMS AVAILABLE ON ITEMS OVER £5.

Send 6d. for 20-page illustrated catalogue. All New Goods. Delivered by return (C.O.D. 2/- extra).

ALL ITEMS GUARANTEED 12 MONTHS. VALVES 3 MONTHS

GLADSTONE RADIO

"SCALA," CAMP ROAD, FARNBOROUGH, Hants. Farnborough 3371. Closed Sat.

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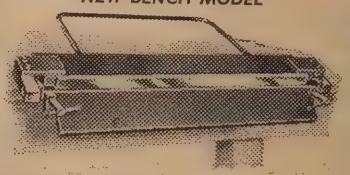
PARKER'S SHEET METAL FOLDING MACHINES

NEW BENCH MODEL



Capacity 36in. wide × 18-gauge mild steel. Forms channels and angles down to 45 deg., which can be flattened to give safe edge. Depth of fold according to height of bench. Will form flanges. Weight approx. 2 cwt.

Price £23, carr. free. Also the well-known vice models of:

36in. × 18-gauge capacity	... £11 10 0	Carriage free
24in. × 18-gauge capacity	... £6 15 0	
18in. × 16-gauge capacity	... £6 15 0	

One year's guarantee: money refunded without question if not satisfied. Send for details:

A. B. PARKER, Wheatcroft Works

WELLINGTON STREET, BATLEY, YORKS. Tel.: 426

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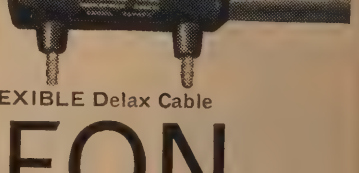
DELAY CABLE, CALIBRATION AND TERMINATION SERVICE



Using Hackethal FLEXIBLE Delax Cable

AEON

AEON Laboratories, Beech Hill, Ridgemead Road, Englefield Green, Egham, Surrey. Egham 3961/4

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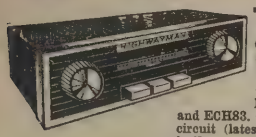
Electronics Centres throughout Great Britain

NEW LOW PRICES — NOW YOU CAN AFFORD A CAR RADIO!



The "HIGHWAYMAN"

OUR QUALITY CAR RADIO TO BUILD YOURSELF AT A NEW LOW PRICE. Look at these features:— ★ Attractive styling. ★ Push-pull output. ★ Three latest Mullard transistors plus valve types EBF83 and ECH83. ★ No buzz, high output and sensitivity. ★ Printed circuit (latest type). ★ 7 × 4in. high flux p.m. speaker and baffle. ★ Medium and Long Waves. ★ Push button for fingertip control. ★ Extremely low battery comsumption (less than ¼ amp.). ★ Easy to fit any make car (positive earth only). ★ 12-volt operation. ★ Compact size, measures only 7 × 7 × 2in. deep. ★ Easy assembly, supplied with dial and drive already mounted. Special inclusive price of **Only £7.19.6** Plus 5/- P. & P. All parts available separately. Individually priced parts list and comprehensive instruction booklet **2/6** post free. (Deducted from cost if complete parcel purchased later).

THE "TRAVLER" MK.II

Introducing our new ready built transistorised car radio for only 9½ Gns. P. & P. 5/-. including 7 × 4in. speaker fitted to baffle, fixing brackets, filter unit, all nuts and bolts with fitting instructions.
H.P. Terms: £2/19/6 deposit (plus P. & P.) and 7 monthly payments of **22/6.**

STAR FEATURES:
★ Handsomely Styled. ★ Mullard Valves and Transistors. ★ Push Buttons. ★ 1½ watts Output. ★ Long and Medium Wavebands. ★ Quality Speaker (E.M.I.). ★ Easily Fitted.
★ Radio Luxembourg (and many other foregin stations). 12-volt Positive Earth Only (applies to 99.8% of cars on the road). ★ Dimensions: 7 × 2 × 7in. depth.
Optional extras: 3-section chromium plated weatherproof telescopic aerials type 1, 17"/44" **19/6.** Type 2, 2"/43" **29/6,** both plus p. & p. 2/6 if purchased separately.

CHASSIS BARGAIN!

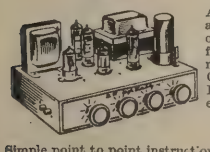
A 6-valve Superhet Radiogram Chassis of outstanding quality covering M.W. 200-550 Metres, L.W. 1,200-2,000 Metres, V.H.F. 87-100 Mc/s. Incorporating internal Ferrite Rod Aerial and the famous Gorler Tuning Heart for V.H.F. Pick-up input suitable for most modern Record Players. Power output 4 watts, valve line-up: EZ80, EABC80, EF86, ECH81, EL84, ECC85. Volume On/Off and Tone Control, attractive black Tuning Dial size 15 × 6in. with gold lettering and contrasting cream and gold knobs. A.C. 200/250 v. Size 15 × 7¾ × 6¼in.
PRICE 16 Gns.
Or **£3/9/-** Deposit (plus P. & P.) and 9 monthly payments of **32/8.** P. & P. 5/-.

CHASSIS BARGAIN!

Latest printed circuit THREE WAVE: Long, Medium and Short. Extremely sensitive. Ferrite rod aerial, 4 watts output. Valve line-up: ECL82 EZ80, EBF89 and ECH81. Tape and gram inputs. Tone control. Attractive dial (size 12½ × 4¼in.) in maroon with gold lettering. Overall chassis size: 14½ × 7½ × 6¼in. A.C. 200/250 v. Fully guaranteed. **SPECIAL PRICE £9.19.6**
P. & P. 5/-.

Or **£2/19/6** Deposit (plus P. & P.) and 7 monthly payments of **22/6.**

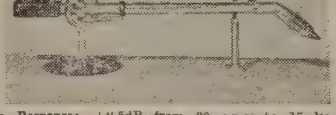
The B.H. HI FIDELITY 14 AMPLIFIER



A first-class amplifier designed for the audio enthusiast and professional musician. **SPECIFICATIONS:** Power output 14 watts. Separate bass and treble controls, full mixing facilities. Ideal for use with guitar. Freq. response 15-20 kc/s. Input 1, 5 m/v. Input 2, 40 m/v. Output imp. 3 or 15 ohms. Valve line-up: 2-EL84, EF86, ECC83, EZ81. Gold hammer finish chassis, engraved Perspex front panel.
PRICE Ready Built 11 Gns.
or in KIT FORM 9 GNS. P. & P. 7/6 each.

Simple point to point instructions supplied with each kit. Top quality components used throughout ensuring perfect results. Instruction book available separately **1/6.** Attractive case with carrying handle available shortly.

OUTSTANDING PRICE REDUCTION!

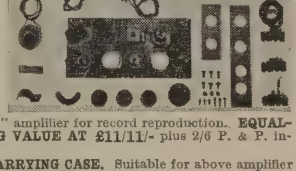


THE B. & O. ST/L PICK-UP COMPLETE WITH SP11 STEREO-DYNE MAGNETIC CARTRIDGE. A Transcription Pickup of outstanding quality employing a specially designed counterbalance and unique weight adjustment. **SPECIFICATIONS:** Length 10⅜in. from tip of Cartridge. Height 2⅜in.
Stereo/Mono Cartridge:—Frequency Response: +2.5dB from 30 c.p.s. to 15 kc. **Output Voltage:** 7 mV. per channel at 5 cm./sec. at 1,000 c.p.s. **Separation:** 20 dB minimum. **D.C. Resistance:** 1,250 ohms. **Inductance:** 200 mH. **Recommended Tracking Force:** 2 to 4 grams. **Compliance:** 5 × 10-6 cm/dyne in all directions. **Stylus:** Diamond, radius of curvature: 7th. **Recommended Load:** 47,000 ohms.
PRICE 9½ Gns. plus 3/6 P. & P.

BUILD YOURSELF AN INEXPENSIVE TAPE RECORDER!

LATEST COLLARO STUDIO TAPE TRANSCRIPTOR—Incorporating Record Interlock Lever, 3 motors, 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push button controls. **NEW LOW PRICE OF £10/10/- ONLY** plus 7/6 P. & P. Usual H.P. facilities.

NEW TAPE RECORDER AMPLIFIER TYPE 8311-V. Sub-assembled—anyone can build Printed Circuit, all components mounted and dip soldered. Already tested. Each lead cut to length. All that is required to complete the tape recorder is for a few components to be mounted in the cabinet and the free end of the leads soldered to terminals which are clearly marked, everything supplied, all you need is soldering iron, pliers and screwdriver. Valve-line-up: EF86, ECC83, 2 × EL84, EZ81 and EM34 magic eye. Monitoring output facilities socket for feeding to high quality amplifier can be used as "straight" amplifier for record reproduction. **EQUALISING ON TWO SPEEDS. OUTSTANDING VALUE AT £11/11/-** plus 2/6 P. & P. including all necessary instructions.



ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE. Suitable for above amplifier and Collaro Studio deck. Fitted 9in. × 5in. High Flux P.M. speaker for high quality reproduction. Inclusive price **£5/5/-** plus 5/- P. & P. Full list of competitively priced mics. and stands on request. The above 3 items purchased at one time **SUPPLIED CARRIAGE PAID.**
NOW AVAILABLE. FOUR-TRACK STUDIO DECK AS ABOVE FITTED WITH HI-FI FOUR-TRACK HEADS. Price **£13/19/6,** plus 7/6 P. & P.
TAPE RECORDER AMPLIFIER 8311-4V exactly as 8311-V but four-track suitable for Hi-Fi four-track heads. **Price £12/12/-.** P. & P. 2/6.
N.B.—Four-track deck and amplifier fit the above case without any modification whatsoever.
PREAMPLIFIER KIT TYPE 8312-CP. Complete high quality pre-amplifier kit for use with Collaro Studio Deck. **Price £8/8/-.** plus 2/6 P. & P.

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RECORDING TAPE BARGAINS

"BEL-CLEER"

FOR THE FIRST TIME IN THIS COUNTRY CANADA'S HI-FI MAGNETIC RECORDING TAPE— Following sizes available — others to follow. BRAND NEW — NOT SUB-STANDARD.
High grade acetate base. Attractively boxed fitted leaders, fully guaranteed:

5in. 8td. 600ft.	12/6
5in. L.P. 900ft.	15/-
5½in. L.P. 1,200ft.	18/6
7in. 8td. 1,200ft.	18/6
7in. L.P. 1,800ft.	25/-

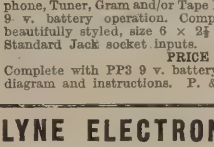
"LAFAYETTE"

AMERICAN RECORDING TAPE. Brand new and boxed. Fully guaranteed.

3¾in. D.P. 600ft. MYLAR	11/6
5in. 8td. 600ft. ACETATE	8/6
5in. L.P. 900ft. ACETATE	10/-
5in. D.P. 1,200ft. MYLAR	15/-
5½in. L.P. 1,200ft. ACETATE	12/6
5½in. D.P. 1,800ft. MYLAR	22/6
7in. 8td. 1,200ft. MYLAR	12/6
7in. L.P. 1,800ft. ACETATE	15/-
7in. L.P. 1,800ft. MYLAR	20/-
7in. D.P. 2,400ft. MYLAR	25/-

(P. & P. 1/- per spool) (4 or more post free)

TRANSISTORISED SOUND MIXER



Mixing 4 channels from high impedance source giving professional results, inputs for high impedance Microphone, Tuner, Gram and/or Tape Recorder 9 v. battery operation. Compact and beautifully styled, size 6 × 2½ × 2¼in. Standard Jack socket inputs.
PRICE 59/6
Complete with PP3 9 v. battery, circuit diagram and instructions. P. & P. 2/6.

ANOTHER NEW ELECTRONICS CENTRE!

NOW OPEN AT

20-22, WITHY GROVE, MANCHESTER 4.

The finest selection of Hi-Fi Equipment and a fully comprehensive range of components etc., for the Do-It-Yourself enthusiast.

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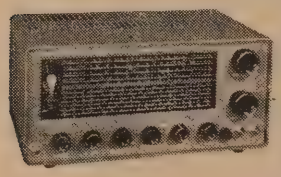
THE WORLD AT YOUR FINGERTIPS!!

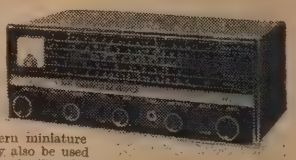
THE HE-30 4-BAND COMMUNICATION RECEIVER



One of the finest general coverage bandspread Receivers available at this price. Covering 550 kc/s.-1,600 kc/s., 4.8 Mc/s.-14.5 Mc/s., 1.6 Mc/s.-4.8 Mc/s., 10.5 Mc/s.-30 Mc/s. Illuminated slide rule dial calibrated every 5 kc/s. on 80 and 40 metres. Edgewise meter, 0-100 logging scale coverage from 0.55-30 Mc/s. 8 valve plus Rectifier Superhet circuit, RF stage with an Aerial Trimmer. 2 IF stages. BFO ontrol. Q-multiplier. Controls: Function Switch, Audio Gain. Selectivity (Q-multiplier), Frequency (BFO), Band Selector, IF gain, Trimmer AVC-MCV Switch, ANL Switch, Main Tuning, Band-spread Tuning and Headphone Jack. Selectivity—60 dB at 10 kc/s., 0.8 kc/s. at 6 dB (with Q-multiplier), IF—455 kc/s. External P.M. Speaker reqd. 4 or 8 ohms impedance. Output 1.5 watts, 8 modern Miniature B7G Base Valves and 5Y3 Rectifier. Size 15 × 10 × 7¾in. Grey crackle finish. For operation on A.C. mains 220/240 v. 50/60 cycles. Full instructions and circuit diagram supplied. Send S.A.E. for leaflet. CARRIAGE PAID

PRICE **40 Gns.**

THE HE 40 4-BAND COMMUNICATION RECEIVER



Completely built and ready to go. High sensitivity Superhet receiver covering 550 kc/s.-1,600 kc/s., 1.6 Mc/s.-4.4 Mc/s., 4.4 Mc/s.-11 Mc/s., 11 Mc/s.-30 Mc/s. Electrical bandspread tuning. Slide-rule type tuning dial. Internal ferrite rod aerial for Medium waveband reception and a 59in. 10-section chromium plated telescopic whip aerial for the Short wave bands. Sockets for optional outdoor aerial. Internal monitor loudspeaker. Latest modern miniature B7G bass valves. Headphone socket (may also be used for external loudspeaker). ANL, BFO, Receive/Stand-by switch. Built-in "S" meter 220/240 volt A.C. mains, 50-60 cycle operation. Handsomely styled cabinet with grey crackle finish and handsome front panel, with chrome and satin chrome fittings. Size 13½ × 8½ × 5½in. Wgt. 11½ lbs. A comprehensive instruction manual is supplied. An ideal receiver for the radio amateur and Short wave listeners of all ages. Send S.A.E. for leaflet. CARRIAGE PAID.

PRICE **£24.15.0**

THE NEW HE-80 COMMUNICATIONS RECEIVER

The HE-80 has outstanding sensitivity, 0-100 logging scale for instant re-set, built-in "S" meter, special recording Jack, remote control socket allowing simultaneous control with transmitter, 100 kc/s. crystal oscillator circuit providing accurate harmonic signals of either 4 or 8 ohms impedance. Two headphone sockets, one high, one low. **Technical Specifications:** Frequency Coverage: Band I, 540-1,605 kc/s.; Band II, 1.6-4.8 kc/s.; Band III, 4.8-14.5 Mc/s.; Band IV, 10.5-30 Mc/s.; Band V, 144-146 Mc/s. Bandspread (Ham Band directly read): 80 Metre Band; 40 Metre Band; 20 Metre Band; 15 Metre Band; 10 Metre Band. Sensitivity: 1 microvolt for 10 dB signal to noise ratio. Selectivity: Normal 10 kc/s. at −75 dB, 1.25 kc/s. at −6 dB. With Q-Multi.: variable to 700 cps at 6 dB. Operation: AM, SSB, CW and FM. AM diode detector. SSB/CW product detector (BFO). FM gated bean detector. Power Source: 240 volts 50/60 cycles A.C. Power Consumption: 60 watts. Audio Output: 1.5 watts, 8 or 500 ohms impedance. Auxiliary Circuits: Electrical Bandspread, Q-Multiplier, ANL, AVC-MVC, BFO, 100 kc/s. crystal colibrator. Valve Line-up: 4-6AQ8, 6BL8, 3-6BA6, 2-6BE6, 6AL5, 6AQ5, OA2, 6CA4. Dimensions: 17in. wide, 6¼in. high, 10in. deep.

PRICE **59 Gns.** Carriage Paid.

"STARFLITE TRANSMITTER"

Designed to meet the needs of most amateurs the Starflite has single-knob bandswitching, front panel switch to select any of five crystal positions with provision for an external VFO. Controlled carrier modulator permits almost 100% of the CW input to be used on AM peaks. Grid-block keying provides chirp-free operation. A full wave silicon diode power supply effects extremely low output ripple for cleaner CW transmission, electron-coupled Pierce Oscillator, capacitance bridge neutralization of the final and a three-stage lowpass filter. An illuminated edgewise D'Arsonval panel meter. Pi-network output provides the correct impedance match between the plate circuit and any 50-72 ohm coaxial feeder. Easy to follow point-to-point instructions supplied with each set of components. When constructed the Unit is housed in a heavy gauge steel Cabinet finished in grey crackle. **SPECIFICATIONS:** Power Input—90 watts peak. Operation: CW, AM Phone—crystal or VFO Control. Band coverage: 80-10 metres. Coupling: Pi-Network. Valve Line-up, 6146, (2) 6CL6, 12AX7, 6DE7. Low Pass Filter. Size 13½in. wide × 12in. deep (ipc. knobs) × 6¼in. high (inc. rubber feet). Weight 28 lbs. Power requirements: 200/240 v. 50-60 cps, 225 watts. MAY BE BUILT FOR

35 Gns. Carriage and Insurance 15/-.

THE LARGEST SELECTION OF MICROPHONES IN THE U.K.!

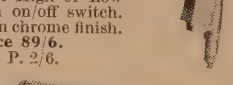
DM.303. Dynamic High Impedance Desk Microphone. Complete with stand. Metallic green finish. **Price 5 gns.** P. & P. 2/6.

DM.301. Dynamic High Impedance with on/off switch. Omni-directional. Chrome-plated diecast frame. **Price 99/6.** P. & P. 2/6.

BM.3. Quality Crystal with muting switch. Chrome and black enamel finish. Complete with lead, neck harness and removable stand adaptor. Price **39/6.** P. & P. 2/6. Matching table stand, **12/6** extra.

DM.304. Dynamic Dual High or Low with on/off switch. Satin chrome finish. **Price 89/6.** P. & P. 2/6.

DX.29. Dynamic High Imp. Black crackle finish. With desk stand. **Price 59/6.** P. & P. 2/6.

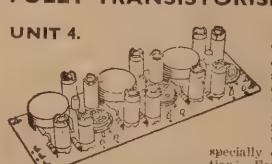


DM.107. Dynamic High Imp. with switch. Chrome and black enamel finish. **Price 69/6.** P. & P. 2/6.

MS.2. Desk stand. 2-section high quality chrome with black enamel base. Dual ⅛in. and ⅜in. screw mike coupling. 9¼in. closed, 14in. extended. **Price 22/6.** P. & P. 2/6.

CM.30. Crystal Microphone with on/off switch and holder. Satin chrome finish. **Price 39/6.** P. & P. 2/6.

MARTIN FULLY TRANSISTORISED AUDIOKITS



UNIT 4.

These ingeniously designed sub-assembled kits enable you to build a transistorised Hi-Fi system by simply linking together your choice of units. No technical knowledge or special tools are needed to build with complete success. All units are supplied on printed circuit boards ready to mount and connect. Latest type transistors used in conjunction with the specially developed circuits give you superb reproduction. For battery operation or can be used on A.C. mains with Martin power supply unit. Following Audiokits available:—**Unit 1.**—3-Stage Matching Input Selector Unit **47/6.** **Unit 2.**—Pre-Amplifier with Master Volume Control, **37/6.** **Unit 3.**—3-Channel Mixer, **79/6.** (Plug-in matching adaptors for above, **8/6** each.) **Unit 4.**—Combined Pre-Amplifier and Tone Control Unit, **62/6.** **Unit 5.**—10 watt Main Amplifier (3 ohm output impedance only at present), **£5/12/6.** **Unit 6.**—Power Supply Unit, **£2/12/6.** P. & P. extra on above items. Full range of attractive Perspex escutcheons available. Send S.A.E. for fully descriptive literature.

SEND S.A.E. FOR COMPLETE LIST OF PRE-RECORDED TAPES
NOW AVAILABLE FROM STOCK

JASON

Complete range available. The following are selected examples only.

FMT1 TUNER. 4 valve with ratio detector plus matched pair germanium diodes. External power supply required. All required components, **£6/15/-.** P. & P. 2/6.

FMT2 TUNER. The modern shelf mounting version of the FMT1 complete with honeycomb case and complete with built-in power supply. All required components, **£10/12/6** P. & P. 4/-.

FMT3 TUNER. 7 valve tuner, with Foster Seeley discriminator. For fringe areas complete with power supply. All required components, **£12/5/-.** P. & P. 4/-.

"MERCURY 2" TUNER. 5 valves with special turret for switching channels to operate on 3 F.M. stations: Home, Third and Light, and TV channels as required. Foster Seeley discriminator. Less power unit. All required components, **£10/12/6.** P. & P. 2/6.

JTV2 TUNER. Switched tuner covering B.B.C., F.M. and B.B.C. TV and ITV. Turret tuner with built-in Foster Seeley discriminator. All required components, **£15/10/-.** P. & P. 4/-.

Instruction books and itemised price lists available separately as follows: FMT1, FMT2, FMT3, 2/6 each. MERCURY 2, JTV2, 3/6 each.

SEE FOLLOWING PAGES FOR MORE ITEMS AND ADDRESSES

9WW—156 FOR FURTHER DETAILS.

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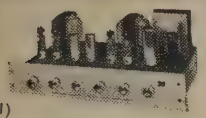
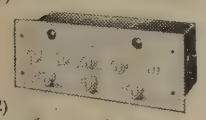
Electronics Centres throughout Great Britain


(1)

(1) MULLARD "10 Plus 10" STEREO AMPLIFIER

A High Fidelity design providing up to 10 watts (per channel).
KIT OF PARTS £20.0.0
BUILT AND TESTED £24.0.0 (C. & I. 7/6.)
We can also supply the **MAIN AMPLIFIER** for operation with our DUAL CHANNEL PRE-AMPLIFIER.
KIT OF PARTS £27.0.0
BUILT AND TESTED £34.0.0
(C. & I. 10/6.)


(2)

(2) MULLARD DUAL CHANNEL PRE-AMPLIFIER

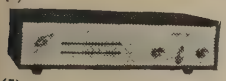
A four-valve design for both STEREOPHONIC and MONOPHONIC operation.
KIT OF PARTS £12.10.0
BUILT AND TESTED £15.0.0
(C. & I. 5/-.)

(3)

(3) THE "TWIN THREE" STEREO AMPLIFIER

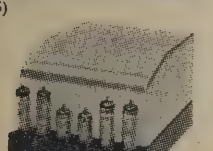
Based on a recent design by MULLARD LTD. it is ideally suited for use in PORTABLE RECORD PLAYERS.
BUILT AND TESTED £9.0.0 (C. & I. 7/6.)
To construct a STEREO PORTABLE RECORD PLAYER we offer:
Assembled AMPLIFIER with two ROLA 8×5in. LOUDSPEAKERS and PORTABLE CASE for **£16/10/0.** (C. & I. 10/-.)

(4)


(5)

(4) THE "TUDOR" STEREO AMPLIFIER

A self-contained shelf mounting Amplifier designed to provide high quality stereophonic and monophonic reproduction.
PRICE ONLY £15.0.0 (C. & I. 7/6.)


(5)

(5) TUDOR STEREO HI-FI SYSTEM

Comprising a self-powered AM/FM Tuner, Stereo Pre-amplifier and 12 watt per channel Stereo Power Amplifier. The Tuner and Pre-amplifier are housed in matching black crackle finish metal Cabinets for shelf mounting, with silver metal dials and matching knobs. SPECIFICATIONS: Tuner—outstanding quality providing full VHF/FM Long and Medium waveband coverage, frequency range FM 87.5-108.5 Mc/s. AM MW 522-1,630 Kc/s. LW 145-270 Kc/s. Multiplex outlet provided. **Pre-Amplifier** —Designed for use with the Tudor Stereo Power Amplifier with inputs for most types of Pick-ups, direct play from Tape Heads and ample sensitivity for either Crystal or Moving Coil Microphone. **Power Amplifier** —14 watts per Channel.
ALL FOR ONLY 48 Gns. (C. & I. 15/-.)

(12)

(12) STEREO TAPE PRE-AMPLIFIER Model STP-I

For use with current TRUVOX, BRENELL or COLLARO "STUDIO" ¼- and ½-track Stereo Decks.
KIT OF PARTS £22.0.0
BUILT AND TESTED £28.0.0
(C. & I. 8/6.)

13)

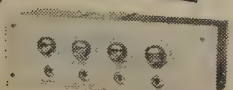
(13) MULLARD TYPE "C" TAPE PRE-AMPLIFIER

Suitable for most ¼-track Mono Tape Decks.
KIT OF PARTS £14.0.0
BUILT AND TESTED £19.10.0
(C. & I. 7/6.)

(14)

(14) MULLARD TAPE AMPLIFIER Model HF/TR3

Based on Mullard's type "A" design and suitable for most ¼-track Mono Tape Decks.
KIT OF PARTS £13.13.0
BUILT AND TESTED £19.0.0
(C. & I. 7/6.)


(15)

(15) MULLARD FOUR-CHANNEL MIXING UNIT

Incorporates two inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK-UPS and a fourth for Radio or Tape.
KIT OF PARTS £8.8.0
BUILT AND TESTED £11.10.0
(C. & I. 7/6.)
Alternative Model I/L provides for one input matched for moving coil or ribbon mike **£1/17/-** extra.

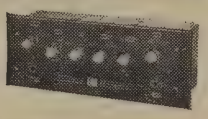
(19)

(19) MODEL CR3/S TAPE RECORDER

Incorporates the HF/TR3 Mk. II Tape Amplifier (described above) and the Collaro "Studio" Twin Track 3-speed Deck operating at 1⅞in., 3¾in. and 7½in. Complete with Microphone and 1,200ft. Tape.
KIT OF PARTS £33.8.0
BUILT AND TESTED £43.0.0
(C. & I. 15/-.)

(6) MULLARD 3-VALVE PRE-AMPLIFIER TONE CONTROL

Designed mainly for the STERN/MULLARD range of Monophonic Power Amplifiers.
KIT OF PARTS £10.0.0
BUILT AND TESTED £13.13.0
(C. & I. 5/-.)


(6)

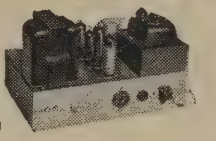
(7) MULLARD 2-VALVE PRE-AMPLIFIER TONE CONTROL

Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIERS but also perfectly suitable for other makes.
KIT OF PARTS £6.6.0
BUILT AND TESTED £9.10.0
(C. & I. 5/-.)

(7)

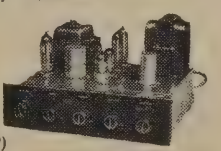
(8) MULLARD "5-10" MAIN AMPLIFIER

For use with MULLARD 2- or 3-valve pre-amplifiers with which an undistorted power output of up to 10 watts is obtained.
KIT OF PARTS £10.0.0
BUILT AND TESTED £13.10.0
(C. & I. 6/6.)
ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER **£1/6/- extra.**


(8)

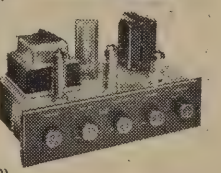
(9) MULLARD "5-10RC" AMPLIFIER

The popular "5-10" complete incorporating Passive Control Unit providing up to 10 watts high quality reproduction with an input of 600 mV.
KIT OF PARTS £12.0.0
BUILT AND TESTED £16.0.0
(C. & I. 7/6.)
WITH PARTRIDGE OUTPUT TRANSFORMER **£1/6/- extra.**


(9)

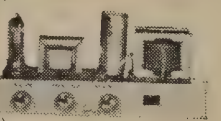
(10) MULLARD "3-3RC"

A HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-WATT MULLARD "3-3" DESIGN.
KIT OF PARTS £8.8.0
BUILT AND TESTED £11.10.0
(C. & I. 6/6.)

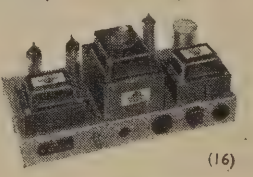

(10)

(11) THE "MONO-GRAM"

A small Amplifier of genuine high quality performance producing up to 3 watts undistorted output.
KIT OF PARTS £4.10.0
BUILT AND TESTED £6.0.0
(C. & I. 3/6.)


(11)

Due to production streamlining we are pleased to announce PRICE REDUCTIONS ON ITEMS 16 & 17


(16)

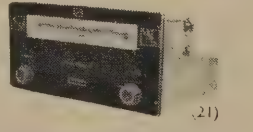
(16) JL10 POWER AMPLIFIER

Incorporates the latest diode/pentode ECL86 valves in push-pull, PARTRIDGE ultra linear output transformer, PARTRIDGE mains transformer and smoothing choke. 10 watts power output, surplus power output, surplus power available for tuner.
KIT OF PARTS £10.10.0
BUILT AND TESTED £13.13.0
(C. & I. 7/6).

(17) DOUBLE FEATURE PRE-AMPLIFIER

Inputs for microphone, crystal or magnetic pick-ups, tuner unit, and in addition offers full facilities for tape recording and high fidelity replay. This unique feature means that should you wish to include tape in your hi-fi system at a later date all that is required is a suitable tape deck. Push-button switching for 3 tape speeds equalised.
KIT OF PARTS £13.13.0
BUILT AND TESTED £19.19.0
(C. & I. 5/-.)
Prices if both units purchased together:
KIT OF PARTS £23.13.0
BUILT AND TESTED £32.0.0
(C. & I. 10/-).

(17)


(21)

(21) Mk. II "FIDELITY" F.M. TUNER UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard amplifiers.
KIT OF PARTS £10.10.0
BUILT AND TESTED £14.5.0
(C. & I. 5/-.)

COMBINED PRICE REDUCTIONS

Mullard 5-10 Main Amplifier and 2-valve Pre-amplifier.
KIT £15.15.0 (C. & I. 8/6.) **BUILT AND TESTED £21.10.0** (C. & I. 10/-.)
Mullard 5-10 Main Amplifier and 3-valve Pre-amplifier.
KIT £19.10.0 (C. & I. 8/6.) **BUILT AND TESTED £25.10.0** (C. & I. 10/-.)
(Above items with PARTRIDGE Transformer **£1/6/-** extra.)

Fully descriptive leaflets available on any of the above items.
INSTRUCTION BOOKS AND DETAILED PRICE LISTS are Supplied Free with Kits of Parts but may be purchased separately if required.
Items 1, 2 and 14, **3/-** each: 6 and 13, **3/6** each; 7, 8, 9, 10 and 21, **2/-** each; 11 and 15, **2/6** each; 12, **5/-**. All Post Free. (Instruction booklet for item 19 is same as item 14.)

9WW—157 FOR FURTHER DETAILS.

TRIPLETONE HI-FI MAJOR £15.18.9

12 watts 15 to 20,000 c.p.s. 5 valves A.C. mains isolated. 12in. x 5¾in. x 6in. high. Built-in pre-amp. and mixer. Two inputs and volume controls. Sensitivity mic. 10 mV.; Gram. 250 mV. 3 tone controls, Bass, Treble and Middle. Auxiliary power supply. 250 v. D.C. 6.3 v. A.C. Portable carrying case, 30/- extra.

New boxed VALVES 90-day guarantee.

OZ4	5/-	6K8G	5/-	EBF80	9/-	PCF82	8/-
IR5	6/-	6L6G	8/-	ECH42	9/-	PCL82	10/-
IS5	6/-	6N7M	5/-	ECH81	9/-	PCL84	10/-
IT4	3/-	6Q7G	6/-	ECL80	9/-	PCL86	10/-
2X2	2/-	6SN7	5/-	ECL82	10/-	PL81	10/-
3S4	7/-	6V6G	5/-	ECL86	10/-	PL83	8/-
3V4	7/-	6X4	5/-	EF85	8/-	PY33	15/-
3Q5	7/-	6X5	6/-	EF86	10/-	PY80	7/-
5U4	6/-	12AT7	6/-	EF89	8/-	PY81	8/-
5Y3	6/-	12AU7	6/-	EF183	10/-	PY82	7/-
5Z4	9/-	12AX7	7/-	EF184	10/-	SP41	3/-
6AC7	4/-	12BH7	7/-	EL34	15/-	SP61	3/-
6AM6	4/-	12K7	5/-	EL84	7/-	U22	7/-
6AT6	6/-	12K8	14/-	EY51	9/-	UBC41	8/-
6BA6	7/-	12Q7	5/-	EY86	9/-	UBC81	9/-
6BE6	5/-	25Y5G	9/-	EZ40	7/-	UBF80	9/-
6BW6	7/-	35L6	9/-	EZ80	7/-	UCH81	9/-
6C4	5/-	35Z4	5/-	EZ81	7/-	UCL82	10/-
6D6	5/-	954	2/-	HABC80		UCL83	12/-
6G6	4/-	DAF96	8/-		10/-	UF89	9/-
6H6	3/-	DF96	8/-	HVR2A	5/-	UL41	9/-
6J5	5/-	DK96	8/-	KT33C	8/-	UY41	7/-
6J6	5/-	DL96	8/-	KT76	8/-	UY85	7/-
6J7G	6/-	EABC80	8/-	MU14	7/-	UU9	7/-
6K6	5/-	EB91	4/-	PC97	10/-	VR150/30	
6K7G	5/-	EBC41	8/-	PCC84	8/-		7/-
		EBC81	8/-	PCF80	8/-	W81	6/-

NEW ELECTROLYTICS FAMOUS MAKES

TUBULAR	TUBULAR	CAN TYPES
1/350 v... 2/-	50/350 v... 5/6	8/600 v..... 9/-
2/350 v... 2/3	100/25 v... 2/-	16/600 v..... 12/-
4/350 v... 2/3	250/25 v... 2/6	16/450 v..... 5/-
8/450 v... 2/3	500/12 v... 3/-	16+16/500 v... 7/6
16/450 v. 3/-	1,000/12 v... 3/-	50/450 v..... 6/6
32/450 v. 3/9	5,000/6 v... 5/-	32+32/350 v..... 5/-
25/25 v. 1/9	8+8/450 v. 3/6	32+32/450 v..... 6/-
25/50 v. 2/-	8+16/450 v. 3/9	50+50/350 v..... 7/-
50/25 v. 2/-	16+16/450 v. 4/3	64+120/350 v... 11/6
50/50 v. 2/-	32+32/350 v. 4/6	100+200/275 v... 12/6

TINNED COPPER WIRE 16 to 22 s.w.g., ¼ lb. 3/-.
ENAMEL WIRE ¼lb. 16 to 22 s.w.g., 2/9, 24 to 30 s.w.g. 3/6. 32 to 40 s.w.g., 4/6. D.C.C. 28, 34, 36 s.w.g., 3/6 2 oz.

CRYSTAL MIKE INSERTS. High output.

Miniature size, 1¼in. dia. x ¾in..... 6/6
ACOS MIKE INSERT 1¾ x ¾in. 8/6
ACOS STICK MIKE 39–1 ..... 35/-
T.S.L. DE LUXE STICK MIKE..... 25/-
TELEPHONE CONTACT MIKE... 10/6
GUITAR CONTACT MIKE..... 15/6

VALVE HOLDERS. EA50 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6 and 7-pin 1/-. Printed circuit B9A, B7G, Int. Oct. 1/-. MORSE KEY 4/6; BUZZER 4/6.
MOULDED Int. Oct. or Mazda Oct. 6d.; B7G, B8A, B8G. B9A 9d. B7G with can 1/6. B9A with can 1/9. Ceramic EF50, B7G, B9A, Int. Oct. 1/-. B7G, B9A cans, 1/- each. Valve base plugs B7G, B9A, Int. Oct. 2/3.

MARTIN TAPE PRE-AMPLIFIERS

(PLAY-BACK THROUGH YOUR OWN AMPLIFIER)
FOR 2 TRACK BSR DECKS 8 GNS.
FOR 2 TRACK COLLARO DECKS 8 GNS.

MARTIN COMPLETE RECORDING AND PLAYBACK AMPLIFIERS

FOR 2 TRACK BSR £8/8/-. COLLARO £11/11/-.

TAPE DECKS

BSR 2-Track £7/5/-. Collaro 2-Track £10/15/-.

HEADPHONES, 2,000 ohms 12/-. 4,000 ohms 15/- pair.
HEADPHONES, moving coil 100 ohms 10/- pair.
SWITCH Cleaner Fluid, squirt spout, 4/6 tin.
SPEAKER-FRET. Gold, Green or Maroon Cloth 17 × 25in., 5/-; 25 × 35in. 10/-. Tygan various colours, 52in. wide from 10/- ft.; 26in. wide from 5/- ft. Samples 1/-.
EXPANDED METAL, Gold, 12 × 12in., 6/-. TYGAN 12 × 12in. 2/-.

MINIATURE PANEL METERS

Size 1¾in. sq. Precision jewelled bearings, 2% accuracy, silvered dials, fine pointers, zero adjustment.
0-1 mA. 27/6; 0-5mA. 27/6; 0-300 V. 27/6; 0-50μa 39/6; 0-500μa 32/6. "S" meter 35/-.

Meter Rectifiers., 12/6 each.
1 m/A., 5 m/A., 10 m/A.

MOVING COIL MULTIMETER 49/6

2in. Scale. Pocket Size.
Readings 0 to 1000 v. A.C.—D.C.
Milliamps 0 to 150
Ohms 0 to 100K

MAINS TRANSFORMERS 200/250 AC Post 2/- each

STANDARD 250-0-250, 80 mA. 6.3 v. 3.5 a., tapped 4 v. 4 a. Rectifier 6.3 v. 1 a. tapped 5 v. or 4 v. 2 a. 22/6
Ditto 350-0-350 ..... 29/6
MINIATURE 200 v. 20 mA., 6.3 v 1 a. 10/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a. 15/6
SMALL, 250-0-250 v. 45 mA., 6.3 v. 2 a. 17/6
STANDARD 250-0-250 65 mA., 6.3 v. 3.5 a. ... 17/6
HEATER TRANS. 6.3 v. 1½ a. 7/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp. 7/6
HEATER TRANS. 6.3 v. 4 a. 10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a. 22/6
AUTO TRANS. 150 w., 0, 115 v. 200, 230, 250 v. 22/6
AUTO TRANS. 500 w. 0, 115, 200, 230, 250 v. 32/6
MULLARD "510" MAINS TRANS. TO SPEC. 33/6
300-0-300 120 ma, 6.3 v. CT 4a, 0, 5, 6.3 v. 2a.

O.P. TRANSFORMERS. Heavy duty 50 mA., 5/6. Small pentode, 4/6. Miniature 3V4, etc., 5/9. Multi-ratio 7/6. Multi-ratio heavy duty push-pull 7 to 10 w., 18/6. Goodmans heavy duty 10/20 w. 6K push-pull, 30/-. Estone ultra-linear OT/ML 10 w., Spec. for "510" 45/-. 10 w. matching transformer, 3, 7, 15 ohms, 12/6.
INTERVALVE TRANSFORMERS. 3 : 1, 5 : 1, 9/- each.
L.F. CHOKES 15/10 H., 60/85 mA., 5/-; 10 H., 85 mA., 10/6; 10 H., 120 mA., 12/6; 10 H. 150 mA., 14/-.
FULL WAVE BRIDGE CHARGER RECTIFIERS. 2, 6, or 12 V. 1½ a., 8/9; 2 a. 11/3; 4 a. 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v., for charging at 2, 6 or 12 v., 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6. Free charger circuit. Ammeter 0-5 a., 10/6.
4 AMP. CAR BATTERY CHARGER with Ammeter Leads, Fuse, Case, etc., for 6 v. or 12 v., 69/6. Ready built.

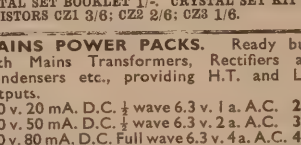
BOOKS (List S.A.E.)

"W.W." Radio Valve Data.....	7/6
High Fidelity Speaker Enclosures...	5/-
Valves Transistors, CRT Equivalents	9/6
At a Glance Valves, CRT Equivalents	3/6
Transistor Sub-Miniature Receivers	5/-
TV Fault Finding	5/-
Mullard Audio Amplifier Manual...	8/6
Radio Valve Guide, Books 1, 2, 3, or 4 ea.	5/-
Transistor Superhet Receivers.....	7/6
Practical Radio Inside Out.....	3/6
Master Colour Code.....	1/6
Practical Tape Recording Handbook	5/-
Coil Design and Construction Manual	5/-
Radio, TV and Electronics Data Book	3/6
International Radio Stations List...	2/6
High Fidelity Stereo Gramophone...	5/-
Modern Transistor Circuits for Beginners	7/6
Principles of Colour T.V. (Patchett)	16/-
Boys' Book of Crystal Sets.....	7/6
Stroboscopic Disc 33, 45, 78 r.p.m....	1/-
Realistic High Fidelity (Hartley) ...	5/-
How to Receive Foreign T.V.....	5/-

CRYSTAL DIODES. G.E.C. 2/-; GEX34, 3/-; OA81, 3/-.
CRYSTAL COILS HAX, 3/6: HAXL 3/6; DRR2 4/6; DRX1 3/-.
CRYSTAL SET BOOKLET 1/-. CRYSTAL SET KIT 12/6.
BRIMISTORS CZ1 3/6; CZ2 2/6; CZ3 1/6.

MAINS POWER PACKS.

Ready built with Mains Transformers, Rectifiers and Condensers etc., providing H.T. and L.T. outputs.
200 v. 20 mA. D.C. ½ wave 6.3 v. 1 a. A.C. 25/6
220 v. 50 mA. D.C. ½ wave 6.3 v. 2 a. A.C. 35/6
250 v. 80 mA. D.C. Full wave 6.3 v. 4 a. A.C. 45/6
TRANSISTOR TYPES. 9 v. Same size as battery PP3 19/6, PP9 45/- (also replaces PP1, PP4, PP7).



ADASTRA 3-3 HI-FI AMPLIFIER READY BUILT, WIRED AND TESTED

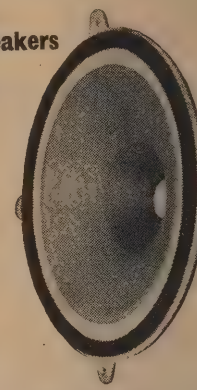
A.C. 200-250 V. Valves ECL86 and EZ80. 3 ohms 3 watts. Controls: bass boost, treble and volume. Separate engraved front-panel. Quality mains transformer. Chassis size 6in. x 5in. x 3in. Price £4/19/6. Details S.A.E.
"Performs agreeably well." (The GRAMOPHONE)

BAKERS 'Selhurst' RADIO

Please see Page 93

Quality Loudspeakers

CHOOSE THE BEST ESTB. 40 YEARS



12in. Stalwart 15w. 45/13 kc/s. 3 or 15Ω 5 gns.
12in. Stereo, foam suspension, 15 ohms. 7 gns.
12in. Standard H.D. 20 w. 40-14,500 c.p.s. 7 gns.
12in. De Luxe foam, 15 w. 25-17,000 c.p.s. 15,000 Lines, Bass Res. 32-38 ..... 9 gns.
12in. Bass 25 w. 20-18,000 c.p.s..... 12 gns.
12in. Ultra Twelve, 20 c.p.s. to 25 kc/s 16 gns.
15in. Auditorium 35 w. Mk. II Bass Res. 36-42 17,000 lines, ideal for guitars, etc.... 18 gns.
Full details and enclosure plans s.a.e.

LOUDSPEAKERS. PM 3 OHM FAMOUS MAKES. 2½in., 3in., 4in., 5in., 6in. × 4in., 15/6 each; 8in. 17/6; 6½in., 16/6; 10in. 30/-; 12in. 30/-; (15 ohms 35/-). 10in. × 6in. 22/6; 8in. × 5in., 9in. × 6in., 21/-.
E.M.I. Double Cone 13 × 8in. 10 w. 45/-; Horn Tweeter 104 dB. 2 Kc/s. to 16 Kc/s. 29/6. Crossover 3000 c.p.s. 30/-; 10in. HF1012, 87/6; 8in. HF812 72/6.
TWIN GANG CONDENSERS "0-0" Transistor 208pF and 176 pF. with trimmers and screen 10/6 each; 365 pF. miniature 1½ × 1½in. × 1½in. 10/-; 500 pF standard with trimmers, 9/-; midget, 7/6; midget with trimmers, 9/-; 500 pF slow motion drive, standard, 9/-. Small 3-gang, 500 pF., 17/6. Single "0" 365 pF, 7/6.
SHORT WAVE. Single 10 pF., 25 pF.; 50 pF., 75 pF., 100 pF., 160 pF., 5/6 each. Can be ganged together. Couplers 9d. each.
TUNING AND REACTION CONDENSERS. 100 pF., 300 pF., 500 pF., 3/6 each, solid dielectric.
VERNIER DIALS. 0-100 Ratio 8:1 1½in. 12/6, 2in. 14/-, 3in. 16/-.
CONDENSERS. 0.001 mfd., 7kV. T.C.C. 5/6; ditto 20 kV. 9/6; 0.1 mfd. 7 kV., 9/6; 100 pF to 500 pF. Micas, 6d. Tubular 500 v. 0.001 to 0.05 9d.; 0.1 1/-; 0.25 1/6; 0.1/350 v. 9d.; 0.5/350 v., 1/9; 0.01/2,000 v. 1/9; 0.1/2,000 v. 3/6.
CERAMIC CONDENSERS. 500 v. 1 pF. to 0.1 mfd., 9d. High voltage pulse ceramics, 100 pF., etc., 12 kV., 2/6.
SILVER MICA. 10% 5 to 500pF., 9d.; 600 to 3,000 pF. 1/-; close tolerance (plus or minus 1 pF.), 2.2 to 47 pF., 1/-; ditto 1% 50 to 815 pF. 1/-; 1,000 to 5,000 pF., 1/9.

465-470 Kc/s SIGNAL GENERATOR

Price 10/6. Ready made with valve 1S5. POCKET SIZE 2½in. × 4½in. × 1in. Only one resistor to change. Full instructions supplied. Battery 8/6. Details free.

WAVE-CHANGE SWITCHES
2 p. 2-way, or 2 p. 6-way, long spindle..... 3/6
3 p. 4-way, or 1 p. 12-way, long spindle..... 3/6
4 p. 2-way, or 4 p. 3-way long spindle..... 3/6
8 p. 4-way, 2 wafer long spindle..... 6/6
Wavechange "MAKITS" Wafers available; 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. Prices include click spindles, adjustable stops, 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/-. Extra wafers up to 12, 3/6 each.
TOGGLE SWITCHES. s.p., 2/-; d.p. 3/6; d.p.d.t., 4/-. Rotary Toggles, s.p., 3/6; d.p. 4/6. Min. Slide d.p. 3/6.
JACKS. English open-circuit 2/6. closed-circuit 4/6. Grundig type 3-pin 1/3; Grundig Lead Type 3/6. Phono Plugs 1/-. Socket 6d. Banana Plugs 1/-. Sockets 1/-.
JACK PLUGS ENGLISH Screened 3/-. Grundig 3-pin 3/6.
BULGIN NON-REVERSIBLE PLUGS and SOCKETS. P74 2-pin 4/3; P73 3-pin 4/6; P194 6-pin 6/6. P360 3-pin 4/-; Mains selector panel with plug 1/-.

C.R.T. BOOSTER TRANSFORMERS

For T.V. Tubes having heater Cathode short circuit and for T.V. Tubes with low emission, full instructions. Mains input.
LOW LEAKAGE WINDINGS WITH OPTIONAL 0%, 25% or 50% BOOST ON SECONDARY.
2 V. OR 4 V. OR 6.3 V. OR 10.3 V. OR 13.3 V. (State Tube voltage required) ea. 10/6

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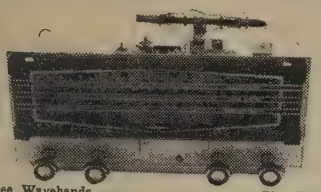
RADIO COMPONENT

Our written guarantee with every purchase. Buses 133 and 68 pass door. S.R. Stn. Selhu

FOR — IMMEDIATE — DESPATCH — PHONE — US — TODAY

1964 RADIOGRAM CHASSIS



Three Wavebands S.W. 16 m.-50 m. M.W. 200 m.-500 mm. L.W. 800 m.-2,000 m. 12-month guarantee. Five Valves Latest Mullard ECH81, EF89, EBC81, EL84, EZ80 A.C. 200-250 v. 4-way switch. Short-Medium-Long-Gram. Ferrite Aerial. A.V.C. and Negative Feedback. 5 watts 3 ohm. Chassis 13¾in. × 7in. high × 5in. deep. Glass dial size 13in. × 4in. horizontal wording. Two Pilot Lamps. Four Knobs. Aligned and calibrated. Chassis isolated from mains.

BRAND NEW £9.15.6 Carr. 4/6.

Matched Speakers 8in. 17/6; 10in. 25/-; 12in. 30/-.

Volume Controls

Long spindles. Midget 5K ohms to 2 Meg. L/S 3/-. D.P. 14/6.

Stereo L/S 10/6. D.P. 14/6. Linear or Log Tracks.

80 Ohm CABLE Coax

Semi-air spaced 6d. yd. 40 yd. 17/6, 60 yd. 25/-

Low loss 5dB per 100ft. at 500 mc/s. Ideal 625 lines 1/6 yd.

CAR AERIAL WING 15/3. PLUGS 1/6. Ditto sockets 1/3. COAXIAL PLUG 1/-. TRIPLEXERS Bands I, II, III 12/6. PANEL SOCKETS 1/-. LEAD SOCKETS 2/-. COAX. OUTLET BOXES. SURFACE OR FLUSH 4/-. BALANCED TWIN FEEDER 6d. yd., 80 or 300 ohms. TWIN SCREENED FEEDER 1/- 80 ohms. EXTENSION SPKR. CONTROL, 10 ohms 3/-; 25 ohms 6/6. TELESCOPIC CHROME AERIALS. 13in. extends to 43in. 8/6 each. T.V. AERIAL B.B.C. and I.T.V. 15/-. RESISTORS. Preferred values, 10 ohms to 10 meg. ¼ w., ½ w., 1 w. 4d.; 1½ w., 8d.; 2 w., 1/-. HIGH STABILITY. ½ w. 1% 2/-. Preferred values, 10 ohms to 10 meg. Ditto 5%, 10 ohms to 22 meg., 9d.

5 watt, 10 watt, 15 watt } WIRE-WOUND RESISTORS 10 ohms 10,000 ohms { 1/3, 1/6, 2/-, 3/-

12.5 K. to 25K. 10 w.

I.F. TRANSFORMERS 7/6 pair
465 kc/s. Slug Tuning Miniature Can. 2×1×1in. High Q and good band width. Data sheet supplied.

WIRE-WOUND Pots. 3 WATT. Pre-set Min. T.V. Type. All values 10 ohms to 25K, 3/- ea., 30K, 4/-; Carbon 30K to 2 meg., 3/-.

WIRE-WOUND 4-WATT STANDARD SIZE POTS. LONG SPINDLE VALUES 50 OHMS. to 50K, 6/6; 100K, 7/6.

TRIMMERS. Compression ceramic 30, 50, 70 pF, 9d.; 100 pF 150 pF, 1/3; 250 pF, 1/6; 600 pF, 750 pF, 1/9; Phillips 0 to 10 pF, 3 to 30 pF, 1/- each. T.V. etc. 1000 pF, with knob, 2/-; RADIO SCREWDRIVER, 5in., 6d. Bulgin Test Prods 2/9 ea. Neosid Trimming tools 1/9. NEON MAINS TESTER-SCREWDRIVER, 5/-. SOLDER MULTICORE 4d. yd. SAVBIT DISPENSER 2/6.

HIGH GAIN TV. PRE-AMPLIFIER BAND 1 B.B.C. Tunable channels 1 to 5. Gain 18 dB. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred for 0.3a heater chains).
BAND III I.T.A.—same prices.
Tunable channels 8 to 13. Gain 17 dB.
coils and circuit only, 9/6. Chassis 4/9, Band I or III.

PAXOLIN PANELS. 1/16in. × 10in. × 8in. 2/-. RECTIFIERS, RM1 5/-; RM2 6/-; RM3 8/-; RM4, RM5, 14A100, 14A116 10/- each; K3/25, 600 v. 5 ma. 5/-. MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 60 mA., 7/6; 250 v. 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6; Full Wave Bridge 250 v. 75 mA., 10/-; 120 mA., 15/-. Silicon 250 v. 450 mA., 10/-. SELENIUM RECT. Popular type. 300 v. 85 mA., 5/-. COILS Wearite "P" type, 4/- each. Repanco. L. and Med. T.R.F. reaction, 4/6 ea. OSMOR MIDGET "Q" type, adj. dust core, from 4/- each. FERRITE AERIALS (VALVE) M, 8/9; M.L. 12/6. FERRITE ROD AERIALS. L. and M. for transistor circuits. OSMOR 10/- each. WEYRAD 12/6 each. FERRITE RODS 8×3/8in. 3/-; 6×3/8in. 3/-; 6×5/16in. 3/-.

QMAX CHASSIS CUTTER

The cutter consists of four parts; a die, a punch, an Allen screw and key.

¼in.	14/6	1¼in.	18/-	2in.	34/3
⅜in.	14/6	1½in.	18/6	2 3/32in.	37/9
½in.	15/6	1⅝in.	20/-	2⅛in.	4/9
⅝in.	15/9	1¾in.	20/-	1in. sq.	31/6
1in.	18/-	1½in.	20/6	1¼in. sq.	28/-
1⅛in.	18/-	1⅝in.	22/6		

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled, 4 sides, riveted corners, lattice fixing holes, 2½in. sides, 7in. × 4in., 4/6; 9in. × 7in., 5/9; 11in. × 7in. 6/9; 13in. × 9in., 8/6; 14in. × 11in. 10/6; 15in. × 14in., 12/6.
ALUMINIUM PANELS. 18 s.w.g. 12in. × 12in., 4/6; 14in. × 9in., 4/-; 12in. × 8in., 3/-; 11in. × 7in., 2/-; 8in. × 6in., 2/-; 6in. × 4in., 1/6.

H.F. CHOKES, all wave, 2/6. Osmor QC1, 6/9. T.R.F. COILS A/HF, 7/- pair. DUST CORES ⅛in., 4d. Purple Cores ¼in. 6d. ALADDIN FORMERS and cores. ¼in. 8d., ⅜in., 10d., 0.3in. FORMERS 5937 or 8 and cans TV1 or 2, ¼in. sq. × 2½in. or ⅜in. sq. × 1½in., 2/- with cores.

BARGAIN XTAL PICK-UP ARM
Complete with ACOS LP-78 Turnover Head . . 20/-

SLOW MOTION DRIVES, Epicyclic ratio 6-1, 4/3. SOLON IRON 25 w. 200 v. or 230 v., 24/-. 65 w. 29/-. A.N.T.E.X. PRECISION sub-miniature iron. 200 or 240 v. 29/6. Stands for A.N.T.E.X. irons 12/6 extra. Spares in stock for above irons.

EAGLE 4 TRANSISTOR PUSH-PULL RADIO AMPLIFIER

Size 4 × 1¾ × ⅞in.

Powerful ready built miniature push-pull amplifier with output transformer, 4 transistors. Ideal for use with record players, intercoms., or "BABY ALARM" Complete with full instructions and circuit.

PRICE **47/6** 9 v. Batt. 2/6 2½in. SPEAKERS 15/-.

MAINS DROPPERS. Midget. With adj. sliders.
0.3A 1,000 ohms, 6/- 0.15A 1,500 ohms, 6/-
0.2A 1,200 ohms, 6/- 0.1A 2,000 ohms, 6/-.
Line Cord 100 ohms ft 0·2a 3-way 1/- ft.

BARGAIN SINGLE PLAYER KIT 200/250v. A.C.
£5.15.0 (less cabinet) **post 5/-**
WITH 2-STAGE AMPLIFIER 3-WATT HIGH-FLUX 5in. SPEAKER, 4-SPEED E.M.I. TURNTABLE CRYSTAL PICK-UP FOR L.P. & 78
Cut out Mounting Board 12⅜ × 9⅞in.

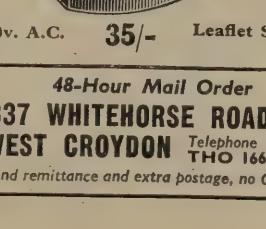
ARDENTE TRANSISTOR TRANSFORMERS
D3035, 7.3 CT:1 Push Pull to 3 ohms for OC72..... 11/-
D3034, 1.75:1 C.T. Push Pull Driver for OC72..... 11/-
D3058, 11.5:1 Output to 3 ohms for OC73, etc..... 11/-
D167, 18.2:1 Output to 3 ohms for OC72, etc..... 12/-
D239, 4.5:1 Driver, ¼in. × ⅛in. × ⅛ in. 11/6
D240, 8.5:1 Driver ¼in. × ⅛in. × ⅛in..... 11/6
ARDENTE TRANSISTOR VOLUME CONTROLS
VC1545, 5K with switch, 5/3. VC1760, 5K with switch 10/6.
DEAF AID EARPIECE Xtal or magnetic, 7/6.
SUB-MIN. JACK and PLUG, 3/6 pair. 2.5 mm. or 3.5 mm.
MIKE TRANSFORMERS 50:1, 3/9.
P.V.C. CONN. WIRE, single or stranded, 2d. yd.
TWIN P.V.C. FLEX, 2 amp., 5d. yd. 3-core 1/-.
SLEEVING 1 or 2 mm., 2d.; 4 mm. 3d.; 6 mm., 5d. yd.
Bib Cutters 3/6. Insulated Side Cutters, 8/6.
Panel mounting fuse-holders 2/-. Fuses 60 mA. to 5 a., 6d.

FAMOUS MAKES PLASTIC RECORDING TAPE

			Spare Spools	
Double Play	7in. reel, 2,400ft.	42/-	3in.	1/6
	5in. reel, 1,200ft.	25/-	4in.	2/-
Long Play	7in. reel, 1,800ft.	22/6	5in.	2/-
	5½in. reel, 1,200ft.	17/6	5½in.	2/-
	5in. reel, 900ft.	15/-	7in.	2/6
Standard	7in. reel, 1,200ft.	17/6	Leader Tape	4/6
	5in. reel, 600ft.	11/6	Splicer Tape	3-
	"EASYSPLICE" Tape Splicer	5/-		

Screws 6BA, 4BA, 6d. doz. Nuts 6BA, 4BA 6d. doz.

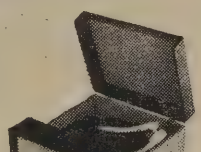
THE "INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETIZER



200/250v. A.C. **35/-** Leaflet S.A.E.

BUILD YOUR OWN RECORD PLAYER

FROM **£9.19.6** AND SAVE POUNDS



4 Speed Autochange or Single Player units supplied with Brand New 2-tone Portable Cabinets 17×15×8½in. Strong carrying handle, gilt finish, clips and hinges. As used by Famous Make for 20 gns. models. Ready cut-out motor board 14×13in. Front baffle with 7×4in. high flux loudspeaker and 3 watt 2 valve UY85, UCL82 2-stage amplifier ready built on metal chassis 12×3×2½in. Quality 3 ohm output transformer, low hum level circuit. Volume and Tone controls, 3 core safety mains lead. All items fit together perfectly. Special instructions enable assembly in 30 minutes, only 5 wires to join. 12 months' written guarantee. Available separately or package deals as below:

AUTOCHANGE KITS Complete—as above.			
B.S.R. Monarch UA14	£11/10/-	P.P.	5/-
Garrard Autoslim	£12/18/-	P.P.	5/-
SINGLE PLAYER KITS Complete—as above.			
E.M.I. Junior	£9/19/6	P.P.	5/-
Garrard SRP10 auto stop/start	£11/15/-	P.P.	5/-
OR SEPARATELY			
Cabinet with board 14×13in. cut out to your choice free of charge.	£3/9/6	P.P.	3/6
Amplifier with 7×4in. speaker	£3/17/6	P.P.	3/6
AUTOCHANGERS			
B.S.R. UA14	£5/19/6	P.P.	3/6
B.S.R. UA15/16	£6/17/6	P.P.	3/6
Garrard Autoslim	£6/17/6	P.P.	3/6
SINGLE PLAYERS.			
Garrard SRP 10 auto stop/start	£5/5/-	P.P.	3/6
E.M.I. auto stop/start	£5/5/-	P.P.	3/6
E.M.I. Junior	£3/7/6	P.P.	3/6
TRANSCRIPTION UNITS			
Philips AG1016 Stereo/mono	£12/5/-	P.P.	5/-
Garrard 4HF Mono xtal	£15/15/-	P.P.	5/-
Garrard AT6 Mono xtal	£10/10/-	P.P.	5/-
Garrard units £1 extra with Stereo/mono xtals.			
BARGAIN Stereo/Mono			
B.S.R. Autochange UA12	£7/10/-	P.P.	3/6
Replacement sapphire styli	5/- diamond		15/-
Replacement Xtals from 15/-; Stereo from			30/-
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NEW MULLARD TRANSISTORS

OC71 6/-, OC72 7/6, OC81D 7/6, OC81 7/6, AF115 10/6, AF114 11/-, OC44 8/-, OC45 8/-, OC171 9/-, OC170 8 6, AF117 9/6. Transistor Holders 1/3. Sub Miniature Condensers. 0.1 mFd., 30 v., 1/3. 1,2,4, 5, 8, 16, 25, 30, 50, 100 mFd., 15 volt 2/6 each.

"6+1" TRANSISTOR RADIO

First-class components to make a 6-transistor 2-wave-band superhet chassis. Ideal for portable or table radio. All parts including BVA transistors, ferrite aerial, printed circuit. 3¼ × 2¼in., but EXCLUDING speaker and cabinet, 35 ohms output. Simple instructions 1/6 (free with kit).
Speakers 35 ohm., 7/4in., 21/-. 5in., 17/6; 3½in., 15/6. **£4.5.0**

WEYRAD

TRANSISTOR SUPERHET TRANSFORMERS, COILS PRINTED CIRCUIT AND FERRITE ROD AERIAL Long and Medium, Wave Aerial—RA2W with CAR AERIAL COIL. 6in. rod 7/16in., dia., 208 pF. tuning 12/6
Oscillator Coil. P50/1AC. 176 pF tuning 5/4
1st and 2nd I.F. Transformers—P50/2CC, 470 K/s. 7/16in. diameter by ⅞in. high, each 5/7
3rd I.F. P40 3CC diode detector 6/-
Drive Transformer LFDT4 ..... 9/6
Printed Circuit PCA1, 2¼in. × 8¼in. Drilled and printed 9/6
Jackson "OO" gang 208+176pF. with trimmers 10/6
Volume control 5K, D.P. 4/6
35 ohm Speakers 3½in. 15/6. 5in. 17/6. 7×4in. 21/-
Wavechange Switch 3/6
Set of 6 Mullard Transistors and diode 42/6
Constructors' Booklet with full details 2/-
3 ohm Output Transformer OPT1 ..... 10/6

B.B.C. 2 TRANSISTOR + DIODE —22/6
M.W. and L.W. Radio Kit. Earpiece 7/6; Battery 2/3. Circuit and Details 6d. Real performance.

SINCLAIR "SLIMLINE" 49/6
2 Transistors plus 2 Diodes. Med. wave kit. Cabinet 3 × 1¾ × ⅞in. Includes earphone, printed circuit Ferrite Rod. Guaranteed no aerial required. Batt. 3/6

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HI-FI 10 WATT AMPLIFIERS
BRAND NEW CARTONED MANUFACTURER'S DISCONTINUED. MODEL. **£7.19.6** Carr. 4/6.
A REMARKABLE OPPORTUNITY. Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs for mike and gram. Separate bass and treble controls. High-sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed, tested and in perfect working order. For 200-250 A.C. mains.

LINEAR TAPE PRE-AMPLIFIER Type LP/1. Switched negative feedback equalisation. Positions for Record 1½in., 3¾in., 7½in. and Playback. EM84 Recording Level indicator. Designed primarily as the link between Collaro Tape Transcriptor and high fidelity amplifier but suitable almost any Tape Deck. **9 GNS.** Send S.A.E. for leaflet.

EXTENSION SPEAKERS, in handsome, walnut veneered cabinets. All standard 2-3 ohms, 6½in. Dia. **29/9.** 8in. **35/9.**

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Bass and treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohms speaker. Three miniature Mullard Valves. Size only 8×5×5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5.19.6** OR Deposit **22/-** and 5 monthly payments of **22/-**. Send S.A.E. for leaflet.

CABY MULTIMETERS. M1. Sensitivity 2,000 ohms per volt. A.C. and D.C. **54/-.** A10. Basic meter sensitivity 155 microamp. A.C. and D.C. ranges. **£4/11/6.** B40. Sensitivity up to 10,000 ohms per volt A.C. and D.C. **£6/2/6.** TMK500 30,000 ohms per volt. A.C. and D.C. **£8/19/6.** Send S.A.E. for leaflet.

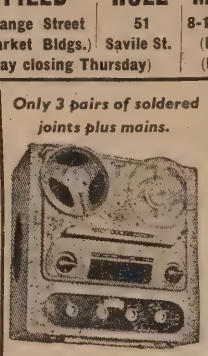
SUPERHET RADIO FEEDER UNIT
Design of a high quality Radio Tuner (specially suitable for use with any of our Amplifiers). Triode Heptrode, F changer is used. Pentode I.F. and double Diode Second Detector. Delayed A.V.C. W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Simple alignment instructions. Only 250 v. 15 mA. H.T. and L.T. or 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost of **5 GNS.** Point-to-point wiring diagrams and instructions **2/6.**

STOCKISTS OF ARMSTRONG CHASSIS, GOODMANS, W.B., and FANE SPEAKERS, LINEAR, LEAK, VERDIK, ROGERS, DULCI AMPLIFIERS, GARRARD and GOLDRING T/TABLES CASH or H.P.

THE SKYFOUR T.R.F. RECEIVER
A design of a 3-valve 200-250 v. A.C. mains L. and M. wave T.R.F. receiver with selenium rectifier. It employs valves 6K7, SP61, 6V6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point to Point wiring diagram, instructions and parts list **1/9.** This receiver can be built for a maximum of **£4/19/6** including veneered walnut cabinet.

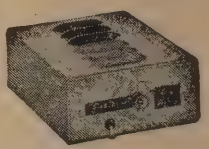
ACOS GP67-2G HI-FI Crystal Cartridges with sapphire stylus. Standard replacement for Garrard, B.S.R. and Collaro. Only **16/9.** Acos Stereo/Monaural **35/9.** Ronette Stereo/Monaural **39/9.**

Only 3 pairs of soldered joints plus mains.



AUDIOTRINE HI-FI TAPE RECORDER KIT
Build a high quality recorder in the £70 class for only
25½ GNS. Carr. 17/6. **Can be assembled in 1 hour.** **OR DEPOSIT £2.13.9** and 12 monthly payments of **44/-.** Cash price if settled in 3 months.
INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR THE AUDIOTRINE HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7×4in. LOUDSPEAKER. Reel of Best Quality TAPE, Spare Tape Spools, & Portable Cabinet. size approx. 14½×15×8½in., finished in durable and attractive duo tone Policrome and connection diagram for wiring amplifier to transcriptor.
FEATURES INCLUDE:
★ 3-SPEEDS. ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZING FOR EACH SPEED ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS. ★ Fast rewind ★ TAPE MEASURING AND CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE. Send S.A.E. for leaflet.

R.S.C. BATTERY TO MAINS CONVERSION UNITS
Type BM1. An all-dry battery eliminator. Size 5½×4½×2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagram **39/9** or ready for use **46/9**
Type BM2. Size 8×5½×2¾in. Supplies 120 v. 90 v. and 60 v. 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed **THEREBY COMPLETELY RELPACING BOTH H.T. BATTERIES AND L.T. 2 v. ACCUMULATORS** when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator.
Complete kit with diagrams and instructions. **49/9** or ready for use **59/6.**



POWER PACK KITS. Only **19/11.** Fully smoothed H.T. output of 250 v. 60 mA. and L.T. supply of 6.3 v. 1.5 amp. Consisting of Double Wound Mains Transformer 230/250 v. 50 c.p.s. A.C. primary. Selenium Rectifier. Smoothing Choke, Double Electrolytic Condenser. Aluminium Chassis and Circuit.

LONDON	EDINBURGH	GLASGOW
238, Edgware Road, W.2. Now open	133, Leith Street Now open (Half Day Wednesday)	326, Argyle Street Now open (Half Day Tuesday)

SENSATIONAL STEREO OFFER
Complete kit of parts to construct a 3+3 watt good quality stereo amplifier providing realistic reproduction. Suitable all stereo pick-up heads. Ganged vol. and tone controls. Pre-set balance. For 200-250 v. A.C. mains only. Fully isolated chassis.
Or including Stereo Head **19/9** extra. **4 GNS.** Carr. 4/6.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

Valves EZ81, ECC 83, ECC83, EL84, EL84. Separate bass and treble controls giving "cut" and "boost." Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch, ganged volume, ganged treble, ganged bass and balance. Output for 3 ohms speakers. Point-to-Point wiring diagrams and instructions. Illustration full wiring details and priced parts list **1/9.** Or supplied assembled and tested 59/6 extra. **8 GNS.** Carr. 7/9.

R.S.C. 3 WATT GRAM AMPLIFIER KIT
All parts to construct a very compact, highly sensitive amplifier suitable for any type of single or autochange player. Size 12×2½×2½in. Chassis is isolated. Mains transformer for 200-250 v. A.C. mains. Output for 2-3 ohm speaker. Volume and tone control with mains switch. Only **39/9**

GL3A MINIATURE 3 WATT GRAM AMPLIFIERS. For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11⅞×2½×2½in. Fitted Vol and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohms speaker. Guaranteed 12 months. Only **59/6.**

SELENIUM RECTIFIERS

L.T. Types		H.T. Types H.W.	
2/6 v. ½ a. H.W...	1/9	120 v. 40 mA.....	3/9
6/12 v. ½ a. HW...	2/9	250 v. 50 mA.....	3/11
Following F.W. (Bridge)		250 v. 60 mA.....	4/11
6/12 v. 1 a.....	3/11	250 v. 80 mA.....	6/11
6/12 v. 2 a.....	6/11	250 v. 250 mA...	11/9
6/12 v. 3 a.....	9/9	Contact cooled	
6/12 v. 4 a.....	12/3	250 v. 60 mA. H.W.	5/11
6/12 v. 5 a.....	14/6	250 v. 70 mA. H.W.	7/11
6/12 v. 6 a.....	15/6	F.W. (Bridge) Types	
6/12 v. 10 a.....	25/9	250 v. 50 mA.....	8/11
6/12 v. 15 a.....	35/9	250 v. 75 mA.....	10/11

R.C.A. 20-WATT RE-ENTRANT SPEAKERS. Matching for 3, 15, 200 and 600 ohms only, **4 GNS.**

TRANSISTOR SALE
Mullard OC71 **3/9.** OC45 **4/11,** OC44 **4/11,** OC72 **4/9.** OC81 **4/11,** OC171 **8/9,** **Ediswan** XA101, XA112, XB113, XB104, XC101A, **3/9** ea. Postage 6d. for up to 3 Transistors.

JASON F.M. TUNERS
Type FM1. All parts including Dial, Escutcheon, Punched Chassis & Valves Power supply required 180 v. 25 mA. and 6.3 v. 1.5 a. **£6/19/6**
Type FMT2... **9 gns**

R.S.C. Battery Chargers & Kits for 200-230-250 v. 50 c/s. A.C. Mains Guaranteed 12 mths.

HEAVY DUTY KIT
6/12 v. variable charge rate up to **6 amps.** Consisting of Mains Trans., F.W. (Bridge), Selenium Rectifier, 0-7 amp. meter. Variable Charge Selector. Fuses, fuse - holders, panels, plugs and circuit. Only **59/9.** Post 4/6.

CHARGER TRANSFORMERS

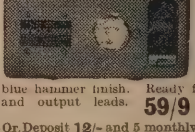
200-230-250 v. 50 c/s.	
0-9-15 v. 1½ a.....	12/9
0-9-15 v. 2½ a.....	14/9
0-9-15 v. 3 a.....	16.9
0-9-15 v. 5 a.....	19 9
0-9-15 v. 6 a.....	23/9
0-9-15 v. 8 a.....	28/9

BATTERY CHARGER KITS
Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels, clips and circuit. Carr. 3/9 extra.
6 v. or 12 v. 1 amp...... **22/9**
As above with ammeter... **28/9**
6 v. 2 amps...... **19/9**
6 v. or 12 v. 2 amps...... **25/9**
6 v. or 12 v. 2 amps...... **35/9**
(inclusive of ammeter)
6 v. or 12 v. 4 amps., with variable charge rate selector and ammeter **52/9**

HEAVY DUTY 14 AMP KIT
at 12 v. (or 24 v. at 7 amp.). Consists of Transformer, Rectifier, Variable Resistor, Ammeter Fuses, Terminals, Stove Enamelled Case and Circuit. Only **10 GNS.** Carr. 15/-.

ASSEMBLED CHARGERS
6-12v.1a. less meter **27/9**
6-12 v. 2 amp Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only **39/9** Carr. 3/9.

ASSEMBLED 6 v. or 12 v. 4 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. **59/9** Carr. 4/6.
Or Deposit **12/-** and 5 monthly payments of **12/-**. As above but for 6 amp. charging. **4 GNS.** Carr. 5/- or Deposit **16/-** and 5 monthly payments of **16/-**.

D.C. SUPPLY KITS. Suitable for electric trains. Consists of mains trans. 200-250 v. 50 c.p.s. 12 v. lamp, selenium rect. (F.W. Bridge); 2 fuse-holders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number **29/11.**

EX GOVT. SELENIUM RECTIFIERS 12 v. 15 amps. F.W. (Bridge). **Only 19/9**

EX. GOVT. SMOOTHING CHOKES
60m A. 10 h. 400 ohms **3/11.** 100 mA. 10h. 100 ohms **6/9.** 150 mA. 10 h. 100 ohms **10/11.** 120 mA. 12 h. 100 ohms **9/9** 200 mA. 5 10 h. 100 ohms **11/9.** 250 mA. 5 h. 50 ohms **10/9**

TANNOY 8 WATT RE-ENTRANT LOUDSPEAKERS. 8 ohms for workshop, factory or outdoor use **25/9** ea.

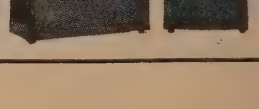
VALVES Full range Keen prices.

CHARGER AMMETERS 0-1½ a., 0-3 a., 0-7 a. **8/9**

HEAVY DUTY SELENIUM RECTIFIERS 24 v. 20 amp. Full wave (bridge). Brand new. **49/9**

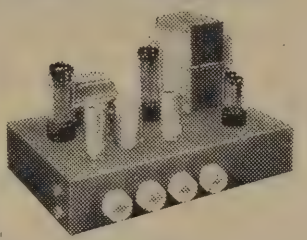
R.S.C. POWER PACKS 200-250 v. A.C. Completely enclosed in louvred enamelled case, 8×5½×2½in. Output fully smoothed 250 v. 60 mA. and 6.3 v. 2 a. **39/9.**

R.S.C. BABY ALARM or INTERCOM. UNIT KIT
For 200-250 v. A.C. mains. Includes all parts, diagrams and instructions. High sensitivity. Completely safe. Controllable at either end. Housed in two cabinets of pleasing design **89/6.** Carr. 5/-. Or assembled and tested **6 gns.**



R.S.C. A10 30 WATT AMPLIFIER

HIGH FIDELITY ULTRA LINEAR PUSH-PULL OUTPUT



SIX VALVES EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. **THIS ENSURES THE SITUABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Base and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associate vol. control is provided so that two separate inputs such as "mike" and gram. etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20mA and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to follow wiring diagram.

ONLY **11 Gns.** Carr. 10/-. Or factory built using latest EL34 output valves and with 12 months' guarantee. **14 GNS. TERMS ON ASSEMBLED UNITS. DEPOSIT 33/9** and 9 monthly payments of 33/9.

Protective Cover **19/9.** Type 807 output valves are used with High Quality Sectionally Wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-20,000 c/s. Tone Controls ± 12 D.B. at 50 c/s. +12 D.B. to −6 D.B. at 12,000 c/s., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12×9×9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS, IDEAL FOR USE WITH MUSICAL INSTRUMENTS, SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.**

LOUDSPEAKERS. 2½in. to 18in. at keen prices. 12in. 6-8 watt 3 ohms **29/11.** 12in. 10 watt 12,000 lines 3 ohms or 15 ohms. **59/9. TWEETERS.** 4in. R.A. 3 ohms **25/9.** R.A. 15 ohms **25/9.** W.B. 15 ohms **32/3.** Fane 15 ohms, Pressure type **£3 15/-.**

FANE HEAVY DUTY HI-FIDELITY SPEAKERS

12in. 15 ohms. **Cast chassis.** Exceptionally robust 2in. diam. Voice Coil Assemblies.

12/10 10 watts ..	5 gns.	12/10A 20 watts ..	6 gns.
12/12 20 watts ..	6 gns.	12/12A 20 watts ..	£7 19 6
12/14 22 watts ..	9 gns.	12/14A 22 watts ..	10 gns.
12/17 25 watts ..	11 gns.	12/17A 25 watts ..	12 gns.

15in. 15 ohms. **Cast chassis.** Exceptionally robust 2in. diam. Voice Coil Assemblies.

152/12 20w.	12 gns.	152/12A 20w.	13 gns.
152/14 27w.	14 gns.	152/14A 27w.	15 gns.
152/17 35w.	16 gns.	152/17A 35w.	17 gns.

"A" indicates dual cone type 30-17,000 c.p.s. Send S.A.E. for leaflets. Terms available.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 15 D.B. negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohms speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-** or assembled ready for use **25/-** extra, plus 3/6 carriage. Or deposit **22/-** and five monthly payments of **22/-** for assembled unit.

R.S.C. TRANSFORMERS Fully Guaranteed. Interleaved & Impregnated.

MAINS TRANSFORMERS. Primaries 200-250 v. 50 c/s.

FULLY SHROUDED. UPRIGHT MOUNTING.

250-0-250v. 60 mA., 6.3 v. 2 a., 0-5-6.3 v. 2a. 2½-3-3in.	17/11
250-0-250 v. 100mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	27/11
300-0-300 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	27/11
300-0-300 v. 130 mA., 6.3 v. 4 a. c.t., 6.3 v. 1 a. For Mullard 510 Amplifier	33/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	33/11
350-0-350 v. 150 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	35/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.....	55/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a.	59/9
450-0-450 v. 250 mA., 6.3 v. 4 a. C.T. 5 v. 3 a.....	69/9

TOP SHROUDED DROP-THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2 a., 0-5-6.3 v. 2 a.....	17/9
250-0-250 v. 100 mA., 6.3 v. 3.5 a.....	19/9
250-0-250 v. 100 mA., 6.3 v. 2 a., 6.3 v. 1 a.....	21/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 0-5-6.3 v. 2 a.....	18/11
250-0-250 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	26/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	26/9
300-0-300 v. 130 mA., 6.3 v. 4 a., 0-5-6.3 v. 1 a., suitable for Mullard 510 Amplifier	29/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	31/9

MIDGET CLAMPED TYPE. Primaries 200-250 v.

250-0-250 v. 60 mA., 6.3 v. 2 a., 2½×2⅝×2¼in.....	12/9
250 v. 60 mA., 6.3 v. 2 a. Size 2½×2⅝×2¼in.....	11/9

FILAMENT TRANSFORMERS 12 v. 1 a. 7/9

6.3 v. 1.5 a.....	5/9	6.3 v. 3 a.	8/11
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/9
		12v. 3a. or 24v. 1.5a	17/9

AUTO (Step Up/Step Down) TRANSFORMERS

50-80 watts 110-120 v./230-250 v.	13/9
150 watts 110-120 v./200-250 v.	27/9
250 watts 110-120 v./200-250 v.	39/9

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012. 10 watts rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. **£4/12/6.** Please state whether 3 ohm or 15 ohm required.

BASS REFLEX CABINET. Designed for above speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18×12×10in. Strongly made. Handsome appearance. Ensures superb reproduction for only **£3/19/6.**

OUTPUT TRANSFORMERS

Midget Battery Pentode 66.1 for 3Ω, etc.....	4/6
Small Pentode 5,000Ω to 3Ω	4/6
Standard Pentode 5,000Ω to 3Ω	5/9
Standard Pentode 7,000Ω to 3Ω	5/9
Push pull 8 watts EL84 to 3Ω	8/9
Push pull 8 watts EL84s to 15Ω	8/9
Push pull 10-12 watts 6V6 to 3Ω or 15Ω	16/9
Push pull 10-12 watts to match 6V6 to 3-5-8 or 15	17/9
Push pull EL84 to 3 or 15Ω 10-12 watts.....	17/8
Push pull Ultra Linear for Mullard 510, etc.....	29/9
Push pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15Ω	29/9
Push pull 20 watt high-quality sectionally wound, EL34, 6L6, KT66, etc., to 3 or 15Ω fully shrouded	47/9

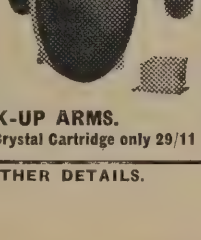
MICROPHONE TRANSFORMERS

120-1 High quality, clamped.....	8/9

SMOOTHING CHOKES

250 mA., 5 H., 100Ω	11/9
150 mA., 7-10H, 250Ω	11/9
100 mA., 10 H., 200Ω	8/9
80 mA., 10 H., 350Ω	5/6
60 mA., 10 H., 400Ω	4/11
1 amp. 0.5Ω L.T. type	6/6

AUDIOTRINE HIGH FIDELITY SPEAKER SYSTEMS



Designed to provide a smooth frequency response from 40-20,000 c.p.s. consisting of 12in. 12,000 line 15 ohm speaker. Crossover Unit and Tweeter. Highly recommended for use with any High Fidelity Amplifier. **10 Watt Unit £4/19/6** or Deposit **11/3** and nine monthly payments of **11/3. 20 Watt Unit £6/19/9** or Deposit **15/9** and nine monthly payments of **15/9.**

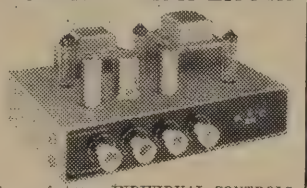
ACOS PICK-UP ARMS.

Fitted Hi-Fi Turnover, Crystal Cartridge only 29/11

R.S.C. A11 12-14 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL ULTRA LINEAR OUTPUT

"BUILT-IN" PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10 High sensitivity. Includes 5 valves ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolt INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs.

For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS, etc. OUTPUT SOCKET** with plug provides 300v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12×9×7in. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring. **8 Gns.** Carr. 10/- diagrams supplied (or factory built **51/6** extra) ONLY

If required louvred metal covers with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 9 monthly payments of 24/9.** Send S.A.E. for illustrated leaflet detailing Cabinets, Speakers, Microphones, etc. with cash and credit terms.

R.S.C. BASS-MAJOR 30 WATT GUITAR AMPLIFIER

A Multi-Purpose High Fidelity, High Output Unit for Vocal and instrumentalist Groups. Incorporating two 12in. heavy duty 25-watt high flux (17,000 lines) loudspeakers with 2in. diameter pole pieces (total flux 220,000 lines). Designed for efficiently handling more than full output of amplifier at frequencies down to 25 c.p.s. One speaker has an aluminium speech coil and dual cone to extend frequency range up to 17,000 c.p.s.

Heavily made cabinet of convenient size 24×21×14in. has an exceptionally attractive covering in two contrasting tones of Vynair. For 200-350 v. 50 c.p.s. A.C. mains operation. EMINENTLY SUITABLE FOR BASS, LEAD or RHYTHM GUITAR AND ALL OTHER MUSICAL INSTRUMENTS. Four jack socket inputs and two independent vol. controls for simultaneous connection of up to four instrument pick-ups or microphones.

Separate bass and treble controls providing more than adequate "Boost" or "Cut" Level frequency response throughout the audible range.

39½ Gns Carr. 17/6. Or DEPOSIT **£4/3/-** and 12 monthly payments of **£3/9/11.**

Superior to units at twice the cost. Send S.A.E. for illustrated leaflet.

R.S.C. JUNIOR GUITAR AMPLIFIER

5-watt high quality output. Incorporating high flux 12in. 10 watt, 12,000 line loudspeaker. Sensitivity 30 m.v. High impedance jack inputs. Handsomely strongly made cabinet (size 14×14×7in. approx.) finished in contrasting shades of Rexine and Vynair. 200-250 A.C. mains operation.

£9/19/6 Carr. 7/6 Send S.A.E. for leaflet.

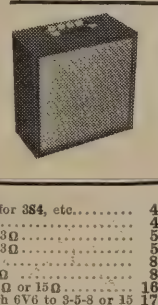
Or DEPOSIT **22/3** and nine monthly payments of **22/3.**

R.S.C. BASS-20 GUITAR AMPLIFIER.

With 15in. 30 watt heavy duty speaker. Robust Rexine covered cabinet. Only **29½ Gns.** Send S.A.E. for leaflet.

LINEAR TREMOLO/PRE-AMP. UNIT Designed for introducing the Tremolo effect to any amplifier fitted with a reserve power supply point for smoothed H.T. and 6.3 v. A.C. This applies to practically all amplifiers of our manufacture and to those of several other manufacturers. The unit plugs into power supply point and any input socket of amplifier. Controls are Speed (frequency of interruptions). Depth (for heavy or light effect). Volume, and Switch. Three sockets are for 2 inputs and Foot Switch. Only **4 Gns.**

MICROPHONES. Full range from 14/9. Also Desk & Floor Stands



R.S.C. SENIOR 15 WATT LEAD OR RHYTHM GUITAR AMPLIFIER. High-fidelity push-pull output. Separate bass and treble "cut" and "boost" controls. Twin separately controlled inputs so that two instruments or "mike" and pick-up can be used at the same time. A heavy duty 20 watt high flux 12in. loudspeaker with cast chassis is used. Cabinet is well made and finished as Junior Model. Size approx. 18×18×8in.

18 Gns. Or DEPOSIT **37/9** and 12 monthly payments **31/6.** Carr. **10/-.** Send S.A.E. for leaflet.

LOUDSPEAKERS IN CABINETS

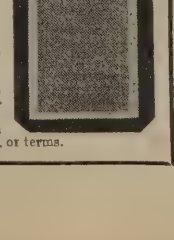
12in. 10 WATT. Walnut Veneered Cabinet size 15×15×8in. approx. High quality 12in. 10 watt 12,000 line speaker, 3 ohms or 15 ohms. **£4/19/6.** Carr. 5/-. Or Deposit **11/3.** and nine monthly payments **11/3**

12in. 20 WATT. High Quality 15,000 line l/speaker 15 ohms in Cabinet finished as above. Size 18×18×8in. **£7/19/6.** Carr. 7/9 or Deposit **17/9** and 9 monthly payments of **17/9.**

15in. 30 WATT. Heavy Duty High Flux Speaker. Suitable for BASS GUITAR. Cabinet 24×21×15in. Heavy construction covered in attractive Rexine and Vynair in two contrasting tones of grey. Only **19½ GNS.** Or Deposit **37/6** and 12 monthly payments **37/6.**

15in. 50 WATT. 14,000 line speaker with 3in. diameter speech coil. 15 ohms Impedance, in Substantial Two-tone Rexine and Vynair covered cabinet of pleasing appearance. Acoustically lined. IDEAL FOR BASS GUITAR. Size 30×24×16in. approx. ONLY **29 Gns.** Or Deposit **£3/15/-** and twelve monthly payments **50/-.**

R.S.C. STANDARD BASS REFLEX CABINET. For 12in. Loudspeakers, acoustically lined and ported. Size 20in. × 14in.×13in. Beautiful walnut veneer finish. Especially recommended for use with Speaker system below, **£5/19/6.** Set of four legs can be supplied with brass ferrules for **19/6.**



AUDIOTRINE CORNER CONSOLE CABINETS. Strongly made. Beautiful polished walnut veneered finish. Pleasing design.

JUNIOR MODEL. To take up to 8in. speaker. Size approx. 20 × 11×8in. Only **49/9.**

STANDARD MODEL. To take up to 10in. speaker. Size 27 × 18×12in. **£4/11/9.**

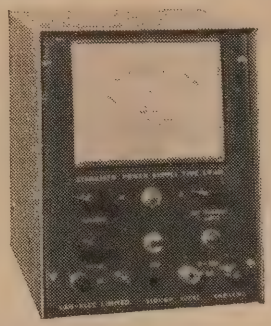
SENIOR MODELS. To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30×30×15in. (Recommended for use with Audiotrine speaker system). **7 Gns.** or terms.

LAN-POWER

NEW RANGE OF TRANSISTORISED STABILISED LOW VOLTAGE

D.C. POWER SUPPLIES

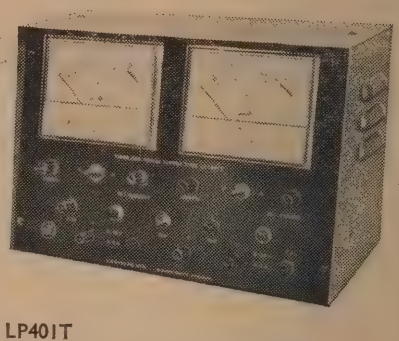
400 Series: High Performance Laboratory Models



- STABILITY > 5000 = 1
- RIPPLE 500μV P-P
- OUTPUT RES < 10 Milliohms
- CONSTANT VOLTAGE
- CONSTANT CURRENT
- FOOLPROOF OVERLOAD
- SMALL SIZE

A complete range of Power Supplies is available including miniature and standard enclosed chassis units. High Current metered bench types etc.

Catalogue and prices on request.



LP401
0-30 v. at 0.5 amp **£37 10 0**
LP411
0-30 v. at 1 amp. **£48 15 0**

LP401T
0-30 v. XO-30 v. at 0.5 Amp. **£68**
LP411T
0-30 v. XO-30 v. at 1 Amp. **£86**

We also manufacture special purpose power units to customers requirements

LAN-ELECTRONICS LTD.

97 Farnham Road, Slough, BUCKS. *Tel: 26647*

Suppliers of high quality power units to H.M. Government

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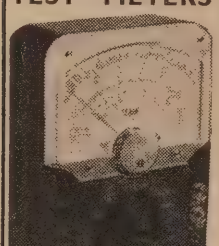
TEST METERS



30,000 OHMS PER VOLT MODEL 500. Reads voltages up to 1,000 D.C. at 30,000 ohms per volt and A.C. at 15,000 o.p.v.; D.C. current to 12 amps. Resistance to 60 Megs.; Decibels from −20 to +56; Incorporates internal buzzer for audible warning of direct shorts and blocking condenser for A.F output measurements. Size 3⅞ × 6⅞ × 2¾in. **£8/19/6.**

2,000 OHMS PER VOLT MODEL TP-10. Reads A.C. and D.C. volts up to 1,000; D.C. current to 500mA; Resistance to 1 Meg.; Capacitance to 1μF; Decibels from −20 to +36; Output jack for Audio measurements. Size: 3½ × 5 × 1½in. **£3/19/6.**

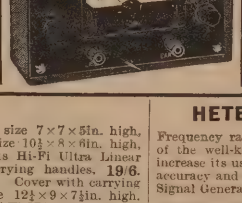
20,000 OHMS PER VOLT MODEL TP-58. Reads voltages up to 1,000 D.C. at 20,000 ohms per volt and A.C. at 10,000 o.p.v.; D.C. current to 500mA; Resistance to 10 Megs.; Capacitance to 0.1μF; Decibels from −20 to +36. Size; 3½ × 5½ × 1½in. **£5/19/6.**

LAVOIE UHF WAVEMEMETER MODEL 105. Coverage 375/725 Mc/s. Complete with correct Calibration Chart. First. class condition. Battery operated and portable. Size 11 × 8 × 7in. ONLY **£3/19/6** (carriage 7/6).

DOUBLE BEAM OSCILLOSCOPE TUBES Another purchase of Type CV 1596, equivalent to Cossor 09D as used in Oscilloscopes by Cossor (339 series) and Hartley & Erskine (13 Series) Listed £12. Brand new in Maker's crates (Carrige 5/-). **25/-**

HIGH FREQUENCY A.C. VOLTMETER. A First Grade Moving Iron Instrument with 6in. Mirror Scale, reading up to 150 v. A.C. at 400 and 1,200-2,400 cycles. In substantial Oak case with removable lid, overall size 8½ × 8½ × 5½in. Made for the Air Ministry by Everett Edgcumb, and in perfect order. Brand New and Unused. ONLY **£5.** Can also be supplied for 50 cycles, use either 0-150 or 0-300 volts.

TRANSISTORISED INSULATION TESTER One handed operation, no cranking of generator 3 testing voltages 100, 250 and 500, to measure up to 500 Meghoms. Complete with leather carrying case and test leads. ONLY **£17/10/-.** Illustrated details on request.



PANEL METERS

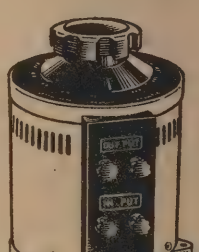
25 microamps D.C. 2½in. Proj. circular **59/6.** 50 microamps D.C. 2½in. Flush circular, **59/6.** 100 microamps. D.C. 2½in. Flush circular **39/6.** 40 amps. D.C. 2in. Proj. circular, **7/6.** 500 volts A.C. 2½in. Flush circular, **25/-.**

'MOVING COIL STICK MIKE' complete with heavy desk stand, and screened lead. ONLY **59/6** (post 2/6).

ACOS 39/1 STICK MIKE with screened lead and table stand. ONLY **32/6.** (Post 1/6.)

CRYSTAL DESK MIKE with screened lead and built-in stand. ONLY **15/-.** (Post 1/6).

15 OHMS P.M. SPEAKERS Special Heavy Duty 12in., **£5/5/-.** Wharfedale W12EG 12in. for Lead Guitars, **£10/10/-.** Wharfedale W15EG 15in. for Bass Guitars, **£17/10/-.** 12in. wedge type speaker cabinet, **£2/17/6.** (Please add 5/- carr. all items.)



VARIABLE VOLTAGE TRANSFORMERS. Fully shrouded. Input 230 v. A.C. 50/60 cycles. Output 0-260 v. 2.5 amps. type **£5/17/6.** 5 amps. type **£9.** 10 amps. type **£16/10/-.** Brand new import, fully guaranteed. Immediate delivery and service. Illustrated details on request.

LINEAR AMPLIFIERS

LG34, 4 watts, size 8½ × 4½ × 2½in. high. **£5/5/-.** L45A 5 watts, size 7 × 7 × 5in. high, **£5/19/6.** Protective cover, **12/9.** L5/55 5 watts stereophonic, size 10½ × 8 × 6in. high, **£12/12/-,** cover with carrying handles **25/-.** "Diatonic" 10 watts Hi-Fi Ultra Linear Push-Pull, size 9 × 7 × 6½in. high. **£12/12/-.** Cover with carrying handles. **19/6.** L1/10 10 watts Hi-Fi Ultra Linear, size 9 × 7 × 5in. high. **£13/13/-.** Cover with carrying handles. **19/6.** "Conchord" 30 watts Hi-Fi Ultra Linear, size 12½ × 9 × 7½in. high. **£16/16/-.** Cover with carrying handles, **25/-.** L50/50 watts Hi-Fi Ultra Linear, size 14 × 10 × 8in. high. **£23/2/-.** Cover with carrying handles **32/6.** All amplifiers for normal A.C. mains, and ex stock. Details on request.

HETERODYNE FREQUENCY METERS TYPE LM14

Frequency range 125-20,000 kc/s. in 2 bands This is the United States Navy Model of the well-known BC221 Frequency Meter, but has many additional features which increase its usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy and in addition it is fitted with an Internal Modulation switch to allow use as a Signal Generator, Size only 8½in. × 8in. × 8½in. Full information on request.

COSSOR TYPE 1035 DOUBLE BEAM OSCILLOSCOPES. A few only of these modern scopes, overhauled and in perfect order ONLY **£45.** Further details on request.

"Tripletone" Convertible Amplifier, size 10 × 3 × 4½in. high. 4 watts output matched for 2-3 ohms, OR 2 amplifiers can be coupled together for STEREO. **£6/19/6** each.
"Tripletone" F.M. Tuner, size 11 × 6 × 3in. high. Coverage 86-104 mc/s. **£13/19/6** (unpowered), or **£15/14/6** (self powered). Details on request.

HARRIS ELECTRONICS (LONDON) LTD.

138 GRAY'S INN ROAD, LONDON, W.C.1 *Telephone TERminus 7937*

Please include carriage costs on ALL items. Open until 1 p.m. Saturdays.

We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.

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LONDON'S LARGEST SUPPLIERS OF ELECTRONIC EQUIPMENT
9 & 10 CHAPEL STREET,
LONDON, N.W.1
Tel. PAD 7851 AMB 5125

HEAVY DUTY L.T. TRANSFORMERS

All primaries 220-240 volts. Terminal block connections.

No.	Sec.	Taps	Price	Carr.
1	25, 30, 35 v., 40 a.		£11 19 6	10/–
2	25, 30, 35 v., 20 a.		£6 19 6	7/6
3	25, 30, 35 v., 10 a.		£4 15 0	5/–
4	25, 30, 35 v. 2 a.		£1 17 6	3/6
5	10, 17, 18 v., 10 a.		£2 17 6	4/–
6	24 volts, 30 amps		£7 15 0	7/6
7	20 volts, 30 amps.		£6 15 0	7/6
8	50 volts, 15 amps.		£6 19 6	7/6
9	30 v., 40 v., 50 v., 5a.		£4 15 0	5/–
10	25, 36, 48 v., 8 a.		£4 19 6	5/–
11	17, 18, 20 v., 20 a.		£4 19 6	5/–
12	6, 12 v., 20 a.		£3 12 6	5/6
13	20 v., 20 a.		£4 15 0	7/6
14	30, 32, 34, 36 v., 5 a.		£2 17 6	4/–
15	6, 12 v., 10 a.		£2 2 6	4/–
16	12 v., 5 a.		£1 9 6	3/–
17	24 v., 10 a.		£3 5 0	4/–
18	24 v., 5 a.		£1 19 6	3/6
19	48, 56, 60 v., 1 a.		£1 9 6	3/6
20	12, 24, 30, 48 v., 2 a.		£2 5 0	3/6
21	6.3 v., 15 a.		£1 17 6	3/6
22	6.3 v., 5 a. and 6.3 v, 1 a.		15 0	3/6
23	12, 24 v., 1 a.		15 0	2/6
24	9, 15 v., 2 a.		17 6	2/6
25	6, 9, 15 v., 4 a.		£1 5 0	3/6
26	12, 18 v., 10 a.		£2 12 7	4/–
27	12, 18 v., 20 a.		£3 19 6	5/–
28	10, 18, 20 v., 9 a.		£3 9 6	5/–
29	15 v. ct., 5 a.		£1 5 0	3/6
30	10-11-12 v., 1½ a.		10 6	2/–

AUTO TRANSFORMERS

240-110 v. 2 kVA. Completely enclosed in metal case. Fitted with 2 two-pin American sockets or terminal blocks. Size 10 x 8 x 6in. Supplied brand new and guaranteed. **£8/15/-.** Carr. 7/6. 1000 watts., **£4/15/-.** Carr. 4/6. 500 watts **£3/10/-.** Carr. 4/–. 300 watts **£2/7/6.** Carr. 3/6. Heavy duty industrial 240-110 v. transformers available up to 10kVA.

DOUBLE WOUND STEP-DOWN TRANSFORMERS

Pri. 220-240 v. Sec. 110 v. 2 kVA. Shrouded. Guaranteed in perfect condition. **£9/15/-.** Carr. 10/–. 300 w. enclosed in metal case fitted with 2-pin American socket or terminal blocks. Pri. 220-230, 240 v. Sec. tapped 110-100 v. **65/-.** Carr. 5/–.

A.M. ISOLATION TRANSFORMERS.

Pri. tapped 100-200-220-240 v. Sec. 225 v. Very conservatively rated at 1.1 amps. double wound. **£3/15/-.** Carr. 7/6.

HEAVY DUTY L.T. TRANSFORMERS

Pri. tapped 105, 115, 125, 210, 230, 250 v. Sec. 27 v., 60 a. Size 11½ x 10 x 8in. Top mounted terminals. Manufactured by famous makers and supplied brand new in original wooden packing cases. **£12/10/-.** Carr. 10/–.

VARIABLE VOLTAGE TRANSFORMERS

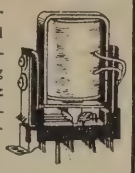
0-260 v. 2½ a., completely shrouded with control knob and dial. Brand new, **£5/17/6.** Carr. 4/–. Other sizes available.
110 v. input. Output 0-110 v. 7 a. panel mounting with control knob. New, **£4/15/-.** Carr. 5/–.

METRO-VICKERS AUTO TRANSFORMERS

230/115 v. 850 watts. Brand new. **£3/17/6.** Carr. 7/6.

LATEST TYPE SILVER PLATED FILAMENT RELAYS

As used in computor equipment supplied complete with socket and mounting clip. Measurement given includes socket. Special prices for quantities.



1,500 + 500Ω	4 CO	contacts	Size	2½ x 2 x ½in. 8/6
700 + 400Ω	4 CO	,,	,,	2½ x 2 x ½in. 8/6
650 + 650Ω	4 CO	,,	,,	2½ x 2 x ½in. 8/6
700Ω	4 CO	,,	,,	1¾ x 1¾ x ½in. 8/6
900 + 500Ω	6 CO	,,	,,	2 x 1¾ x 1in. 10/6
375 + 400Ω	12 CO	,,	,,	2 x 2 x 2in. 10/6
350 + 550Ω	12 CO	,,	,,	2 x 2 x 2in. 10/6
500Ω	12 CO	,,	,,	2 x 2 x 2in. 12/6

SPECIAL OFFER AIR MINISTRY L.T. D.C. SUPPLY DISTRIBUTION BOARDS

Type 5F/3289. For use with D.C. Supply up to 36 volts. Six independent separate 1 amp. outlets. Each with 0-1 amp. 2½ inch flush meter, variable control, panel light, fuses and on/off switch. Also master voltmeter 0-40 volts and 6 position meter switch, built in metal case size 24 x 17 x 7 inches.

An ideal unit for Schools and Laboratories, the Electronic industry and large Model and Exhibition Lay-outs. Supplied brand new in wood packing cases at a fraction of maker's price, which is excess of **£80.**

Used in conjunction with our S.E.I. L.T. supply unit (D.C. output 12-24 v. 8 amp.), the Board will give six 0-24 v. 1 amp. controlled outlets. For 0-36 v. outputs, rectifier and transformer can be supplied. Limited number only. Photograph of the above unit will be sent on request. **Price £17/10/-.** Ex. warehouse.

SELENIUM F.W. HIGH CURRENT BRIDGE RECTIFIERS.

Supplied brand new and guaranteed. Not to be confused with Government Surplus. All materials used are the latest design and highest grade.

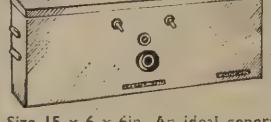
PLATE SIZE 7¾in. SQUARE

No. 1.	36 V. D.C., 36 amps.	...	£11/15/0	carr. 7/6
No. 2.	36 V. D.C., 18 ,,	...	£5/17/6	,, 7/6
No. 3.	24 V. D.C., 54 ,,	...	£11/15/0	,, 7/6
No. 4.	24 V. D.C., 36 ,,	...	£5/19/6	,, 7/6
No. 5.	24 V. D.C., 18 ,,	...	£3/19/6	,, 7/6
No. 6.	12 V. D.C., 54 ,,	...	£5/17/6	,, 7/6
No. 7.	12 V. D.C., 36 ,,	...	£3/19/6	,, 7/6
No. 8.	12 V. D.C., 18 ,,	...	£1/19/6	,, 3/6
No. 9.	12 V. D.C., 12 ,,	...	£1/12/6	,, 3/6

PLATE SIZE 4½in. SQUARE

No. 10.	36 V. D.C., 8 amps	...	£2/19/6	carr. 3/6
No. 11.	24 V. D.C., 8 ,,	...	£1/19/6	,, 3/6
No. 12.	12 V. D.C., 8 ,,	...	19/6	,, 2/6

L.T. SUPPLY UNIT TYPE S.E.I.



A.C. input 200-240 v. D.C. Output tapped to give 12 or 24 volts 8 amps. continuous rating. Fitted with panel fuse. Mains on/off switch and D.C. output socket. Built in strong metal case. Size 15 x 6 x 6in. An ideal general purpose L.T. supply unit for operating relays. Contactors, battery charging, etc. **£9/19/6,** carr. 7/6.

We have large stocks of low resistance L.T. smooth chokes, high capacity electrolytics, industrial type volt and ammeters, A.C. blowers, L.T. supply units, rheostats and sliding resistor, selenium F.W. bridge rectifiers, relays and contactors. Let us know your requirements. Monthly account orders accepted from the electronic industries, Universities, Colleges and Schools.

HEAVY DUTY SLIDING RESISTORS

Ω	Amps.	Type	Price	Carr.
100	1	S. tube enc.	25/–	3/–
4	8	Ditto	30/–	4/–
1	12	Ditto	12/6	2/6
6.5	5	Ditto	22/6	2/6
78	5	D. tube, open	65/–	5/–
15	8	Dble tube r/angle	35/–	5/–
12,000	.003	Dble tube grd. drive	20/6	5/–
1:2	10	Single tube rot. sweep	17/6	3/–
0.75	12	Ditto	17/6	3/–
26	4	6in. dia. rheostats	45/–	4/–

G.P.O. MAGNETIC COUNTERS

Latest design size 3¾ x 1 x 1in. Type 100D 4.1Ω 3 v. D.C. **12/6.** Type 100A 500Ω 24 v. D.C., **12/6.** P.P. 1/6. New and boxed.

HADDON L.T. TRANSFORMER

"C" core. Fully tropicalised. Pri. 240 v. Sec. tapped, 53.5—55.2 v. 6 a. Very conservatively rated, **£3/17/6,** carr. 7/6.

L.T. TRANSFORMER UNIT

Type AP61774. A.C. input 220-240 v. comprises of Parmeko "C" core, enclosed type transformer 24 volts 2 amps. Built into metal case, size 8½ x 5 x 4in., with fitted neon indicators. Fuses. Input and output terminals. Supplied brand new at a fraction of maker's price, **27/6,** carr. 5/–.

L.T. SUPPLY UNIT No. 46.

A.C. input tapped 110-220-230 v. D.C. output 24 volts 1.5 amps. 2.25 amps with case cover removed. Choke and condenser smoothed. Fitted on/off switch and fuses. Built in metal case. Size: 15 x 9 x 9 inches. Supplied new and guaranteed. **£3/17/6.** Carr. 7/6.

NIFE BATTERIES TYPE T.A.2.

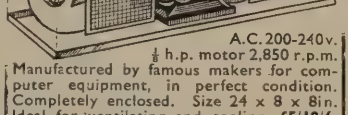
Nickel cadmium alkaline. 20 A.H. 12 v. 10 cells connected in strong wood case, size 20¾ x 8½ x 4½in. New and guaranteed. **£4/19/6.** carr. 7/6.

HIGH VOLTAGE CERAMIC CAPACITORS

PF	V. D.C. wkg.	Price
15	5000	2/6
32	5000	3/6
50	10000	4/6
65	7500	4/6
100	7500	4/6
125	10000	5/6
150	7500	5/6
600	5000	6/6
600	9000	7/6
700	5000	7/6
1400	5000	8/6

Please send 1/6 P.P.

TWIN TURBO BLOWERS



A.C. 200-240v. ⅛ h.p. motor 2,850 r.p.m. Manufactured by famous makers for computer equipment, in perfect condition. Completely enclosed. Size 24 x 8 x 8in. Ideal for ventilating and cooling, **£5/19/6.** Carr. 10/–.

200 AMP. L.T. TRANSFORMERS

Pri. 240 volts. Sec. tapped 4-6-11 volts.

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DO IT YOURSELF

Build a Record Player and Save Pounds

The Cheapest The L.K. Way

Famous Autochanger or Single Player Units supplied with brand new, two-tone, de-luxe portable cabinets, 17×15×8½in. Strong carrying handle, gilt finish clips and hinges as used by famous make for 22 gn. model. Ready cut out motor board, 14×13in. Front baffle 7×4in. High flux loudspeaker and 3 watt amplifier. Amplifier ready built on metal chassis with output transformer, volume and tone controls. All items fit together perfectly. Special instructions enable assembly in 30 minutes. Only 5 wires to join. 12 months' written guarantee. Available separately or package deals as below.

L.K. PRICES FOR COMPLETE KITS:

Autochange Kits as above				
B.S.R. U.A.14 Mono	£10	17	6	P.P. 5/6
Garrard Autoslim Mono	£11	7	6	P.P. 5/6
Single Player Kits as above				
Garrard S.R.P.10 Mono	£10	12	6	P.P. 5/6
E.M.I. Autostop Mono	£10	17	6	P.P. 5/6
Individual Prices for those who wish to purchase separately:—				
Record Player Cabinet with Cut out Board	£3	0	0	P.P. 3/6
Amplifier with 7×4in. speaker	£3	10	0	P.P. 2/6
Auto-changers				
B.S.R. U.A.14 Mono Cartridge	£5	7	6	P.P. 5/6
Garrard Autoslim Mono Cartridge	£6	0	0	P.P. 4/6
Single Players				
E.M.I. Autostop Mono Cartridge	£5	7	6	P.P. 4/6
Garrard S.R.P.10 Mono Cartridge	£5	0	0	P.P. 4/6
E.M.I. Separate Pick-up Mono Cartridge	£3	0	0	P.P. 3/6
Transcription Units—Stereo—Mono				
Garrard 4 H.F. Stereo Head	£14	10	0	P.P. 5/–
Philips A.G.10/16 Stereo Head	£12	0	0	P.P. 5/–
Garrard A.T.6. Stereo Head	£9	19	6	P.P. 5/–

- **SCOOP!** Cartridge LP/78 by Famous Manufacturer for B.S.R. UA/14 Garrard Slimline, etc. List Price 35/-. OUR price 9/6, P.P. 1/6. Brand new, guaranteed.
- **SCOOP!** Set of 6 Transistors and Diode. Brand new in presentation case with circuit. OUR price 15/-. P.P. 1/-.
- **SCOOP!** Elpico Major Stereo Amplifier, 5 watts per channel. Ideal Guitar Amplifier. A.C. only. Facia in Black/Silver. Brand new in maker's unopened carton. Guaranteed. List price £15/15/-. OUR price £7/10/-. P.P. 4/6. Please send for our complete amplifier lists. Hi-Fi Equipment the cheapest in the trade.
- **SCOOP!** 1964 Radiogram Chassis. **STEREO** 3-wave bands, long, medium, short. 5 watts per channel. 6 valves. Latest Mullard. A.C. 200/250 v. Ferrite aerial. Glass dial, horizontal wording. Size 13in. × 4in. Aligned and calibrated. Concentric controls. Isolated chassis. Size 13½in. × 9in. high × 5in. deep. Product of Famous National Manufacturer. Brand new and boxed. Maker's guarantee. OUR price £13/10/-. List price £19/8/-. P.P. 5/6. Our Chassis List quotes prices—the keenest in the Trade. We are Main Agents for the complete range of Brittamer Chassis and Amplifiers. "Brittamer"—makers of Radiogram Chassis to the Top Names in Radio.
- **SCOOP!** Transistor Tape Recorder. The best obtainable by very famous manufacturer. Brand new. Boxed and guaranteed. Reduced from 12 gns. OUR price £7/10/-. P.P. 3/6. Complete with Microphone, Tape, Batteries and Operational Booklet. Operation, pause, speed, wind/rewind, record/playback. Can be used in any position—indoor or outdoor.
- **SCOOP!** 10in. Speakers by W.B. of Mansfield. A beautiful Hi-Fi Speaker, magnet flux density 12,000 lines gauss. Brand new in maker's carton. Fully guaranteed. OUR price 42/- only. P.P. 2/9. Please send for our Speaker Lists. Our prices the most competitive in the Trade.
- **SCOOP!** B.S.R. UA/14 Auto Changers. Brand new and boxed. Wired for stereo. Mono Cartridge. Note OUR price, £5/7/6. P.P. 5/-.
- **SCOOP!** Garrard Auto Slims. Brand new and boxed. Wired for stereo. Mono Cartridge. Note OUR price, £6 only. P.P. 5/-.
- **SCOOP!** Diodes—over 1,000,000 in stock. Ideal substitute O.A.81 Vision Detector. Note OUR price, £1 per 500. P.P. 2/-. (In lots of 500 only.) All guaranteed.
- **SCOOP!** Now available our Short-wave Receiver Mk. II. in kit form. A wonderful little set. Dry battery operated. Radio Australia received in Surbiton, Surrey, at reasonable strength. Coverage 3.5 Mc/s. to 12 Mc/s.—11 Mc/s. to 30 Mc/s. Note OUR price, 42/- only. All components fully guaranteed. P.P. 2/3.
- **SCOOP!** Record Player Amplifier. Product of National Manufacturer. 2 valve A.C. Mains. Output 3 watts. Complete with speaker, Output Transformer, Valves, Knobs, etc. Fully wired, tested and guaranteed. Mounted on baffle board ready for cabinet. Note OUR price, 50/- only. P.P. 3/6.
- **SCOOP!** Brand new A.M./F.M. (V.H.F.) Radiogram Chassis at £12/15/- (carriage paid). Chassis size 15×6¾×5½in. high. New manufacture. Dial 14½×4in. in 2 colours, predominantly gold. 200-250 v. A.C only. Pick-up Ext. Speaker, Ae., E., and Dipole Sockets. Five push buttons—OFF, L.W., M.W., F.M. and Gram. Aligned and tested. O.P. Transformer. Tone Control. 1,000-1,900 M., 200-550 M., 88-98 Mc/s. Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. Speaker 8×5in. and Cabinet to fit chassis (table model), 47/6, post 5/-. 10×6in. Elliptical Speaker, 25/- to purchasers of this chassis. Alternative Design. L.W. 1,000-1,900 M. S.W. 9-15 Mc/s., M.W. 190-475 M. V.H.F. 87-100 Mc/s. Gram. position. Otherwise similar to above chassis. Price £13/5/- (carr. paid).
- **SCOOP!** TAPES. We are reducing our huge stocks of Paper, Acetate and Mylar. All sizes. Spare Spools also available. Let us quote you at our expense. Special prices for lots of 1 doz. and over.
- **SCOOP!** A limited number only. Tape Decks by B.S.R. Latest Model. A.C. 200/240 v. Brand new and boxed. OUR price £6/10/- only. P.P. 4/6. Please send for complete list of Tape Decks.
- **SCOOP!** Microphones. Complete lead, Co-ax. plug, dynamic. Brand new. OUR price 5/- only. P.P. 1/6.

TRANSISTOR SECTION

- **SCOOP!** A first-class 2 waveband 6 Transistor Superhet Chassis by world-famous manufacturer. Fully built, aligned, tested, guaranteed. Full coverage long and medium waves. Our price £4/4/- only. Suitable Speaker 10/6. A few cabinets can be supplied at 22/6 each. OUR price for the Package Deal, £5/5/- only.
- **SCOOP!** As above, 7 Transistor. OUR price £4/15/- only. Suitable Speaker 10/6. A very attractive Cabinet, 22/6. OUR price for the Package Deal, £5/14/- only.
- **SCOOP!** As above, 8 Transistor. OUR price £5/4/- only. Suitable Speaker, 10/6. Cabinet (very attractive two-tone), 22/6. OUR price for the Package Deal, £6/10/- only. P.P. on ALL the above 2/9.

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The cheapest, the best, the quickest service. **If not advertised it is still in stock**

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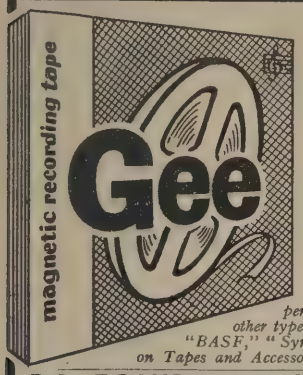


FIRST QUALITY FACTORY FRESH TAPE!

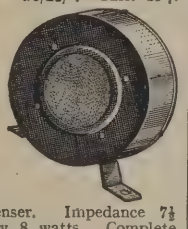
5in.	Std.	600ft.	Mylar	8/6
7in.	Std.	1,200ft.	Mylar	12/6
5in.	L.P.	900ft.	Acetate	10/-
5in.	L.P.	900ft.	Mylar	12/6
5½in.	L.P.	1,200ft.	Acetate	12/6
5½in.	L.P.	1,200ft.	Mylar	15/-
7in.	L.P.	1,800ft.	Acetate	15/-
7in.	L.P.	1,800ft.	Mylar	20/-
4in.	D.P.	600ft.	Acetate	9/-
5in.	D.P.	1,200ft.	Mylar	15/-
5½in.	D.P.	1,800ft.	Mylar	22/6
7in.	D.P.	2,400ft.	Mylar	25/-

Where not stated, please add P. & P. 2/- per order. (Orders over £3 post free.) Many other types available including "SCOTCH," "EMI," "BASF," "Synchrotape," etc. Send S.A.E. for our huge money-saving literature on Tapes and Accessories. **SPECIAL DISCOUNT FOR TAPE QUANTITIES.**

''GEE'S'' SUPER QUALITY MESSAGE TAPES. 3in. Std. 150ft. **3/9**, 3in. L.P. 300ft. **5/-**; 3in. D.P. 400ft. **8/6.** On brightly coloured spools in neat plastic cassettes. Ideal for gifts of messages.

P.A. EQUIPMENT

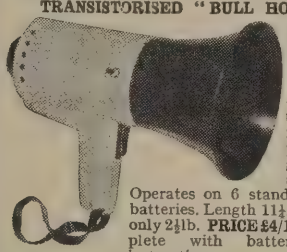
RE-ENTRANT LOUD HAILERS (Ex Govt.) Heavy duty 20 watts., all metal, 15 ohms. Dia. 15in., length 15in. (approx.). Brand new and boxed, **£9.** Carr. 10/-. Ditto reconditioned, **£6/10/-.** Carr. 10-/.



6 inch P.M. HEAVY DUTY SPEAKERS. Complete with line trans., in all steel blue-grey double grilled cabinet, **30/-.** P. & P. 3/-. Ditto, with 10in. P.M. speaker, **39/6.** Carr. 6/-.

TRUVOX TANNOY LOUD HAILERS. With 180 ohm line transformer and condenser. Impedance 7½ ohms, handling capacity 8 watts. Complete in slope-front wooden case, **30/-.** Carr. 5/-.

TRANSISTORISED "BULL HORN"



Ideal for Sports meetings, building sites, etc. Range up to 200 ft. Simply press trigger switch and talk. Operates on 6 standard 1½ v. batteries. Length 11½in. Weight only 2½lb. **PRICE £4/15/-.** Complete with batteries and instructions.

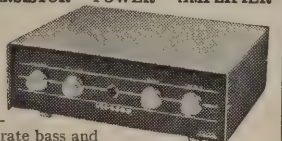
15 WATT TRANSISTOR POWER AMPLIFIER
A new transistor Audio Frequency Amplifier of new modern design incorporating a number of additional practical features. Operates on 12 volts. Power output 15 watts. Output impedance 25, 15 or 3.75 ohms. Inputs for mike and gram. Frequency response 100 c/s. to 10 kc/s. Incorporates on/off switch, volume control, tone control, pilot lamp. Complete in pale green hammer finish metal case, size 6 × 3½ × 5½in. Weight 4½ lb. Made in England. Brand new and fully guaranteed. All parts replaceable. **ONLY £21.**

G.P.O. STANDARD 19in. HEAVY DUTY EQUIPMENT RACKS
4ft. 6in. Channel Uprights, **£4.** Carr. 15/-.
5ft. 6in. Angle Uprights, **£4/10/-.** Carr. 15/-.
6ft. Channel Upright, **£6.** Carr. 20/-.
7ft. Channel Upright, **£7.** Carr. 20/-.
All with Heavy Duty Base.

GEE BROS. RADIO LTD.
15 LITTLE NEWPORT STREET, LONDON, W.C.2 GER. 6794/1453
Open 9-6 Mon. to Fri. 1 p.m. Sat.
Adjoining Leicester Square Tube.

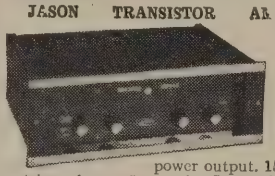
ALL TRANSISTOR POWER AMPLIFIER MODEL K3T.

30 WATT



100/250 A.C. mains operation. Separate bass and treble controls. Output impedance 4-10 ohms transformerless. High and low impedance inputs for dynamic or crystal microphone and pick-up. Has 2 separate input channels and 2 separate volume controls enabling input signals to be mixed or faded from one channel to the other. Size 9¾in. × 8 5/6in. × 3in. Complete with circuit diagram and full instructions. **PRICE £26/10/-.** P. & P. 5/-.
Also model K2T as above but 15 watt output. **PRICE £17/17/-.** P. & P. 5/-. S.A.E. for leaflet.

JASON TRANSISTOR AMPLIFIER



200/250 v. A.C. mains operation. Separate bass and treble controls. 10 watt power output. 15 ohms output impedance. Inputs for Gramophone, Radio, Tape. Complete with circuit diagram and full instructions. Brand new with maker's guarantee. Originally £22. **OUR PRICE £14.** Few only!

DUAL IMPEDANCE SLIM DYNAMIC MICROPHONE. Model PA.46. Beautiful, professional-looking, with solidly cast, tapered slim case. Heavy duty on-off slide switch. Built-in transformer supplies dual unbalanced impedances—low 600 ohms, high 50,000 ohms. Omnidirectional when used vertically—cardioid pattern when tilted. Complete with 5ft. plug-in cables. **PRICE £4/4/-.** P. & P. 2/6.

STUDIO CRYSTAL MICROPHONE. Model PA.17. A fine quality all directional microphone with a 360° pick-up and the added power and sensitivity of two individually shock mounted and phased crystal cartridges, giving maximum pickup from all sides. Overall size 7in. H. × 3in. W. complete with 4ft. cable. **PRICE £2/2/-.** P. & P. 2/6.

"DYNA-SLIM" MICROPHONE
MODEL PA.43. Dynamic 50K high impedance microphone with on/off switch. Omnidirectional head. Length 8in., 1¼in. dia. tapered. Complete with cable and connector. **69/6.** P. & P. 2/6.

CRYSTAL MICROPHONE MODEL BM.3
Three-way mike for hand, desk or floor stand use. Response 100-8,000 c/s. Sensitivity — 62 dB. Length 7in. Head dia. 1¼in. Supplied with neck band, lead and standard jack plug. ONLY **39/6.** P. & P. 2/-. Table stand 12/6 extra.

MICROPHONE FLOOR STAND (Telescopic). HEAVY 9in. dome, chromium base, chromium stand with screw top. Extends to approx. 6ft. **55/-.** Carr. 5/-.

WANTED FOR CASH!!
Good quality modern P.A. Equipment, Test Equipment, Hi-Fi Equipment, what have you! Single items or quantities. Offers by return.

OUTSTANDING BUYS IN QUALITY MULTIMETERS

100,000 o.p.v. MULTI-TESTER Model 370-N. Incorporates 9.5 μA. basic meter, scale size 4 × 2½in. Ranges D.C. volts, 8 ranges 100 mV. to 5 kv. D.C. amps., 7 ranges, 10 μA to 10 A. A.C. volts, 6 ranges 2.5 v. to 1 kv. Ohms 5 ranges 0-50 megohms and 5 ranges 40 ohms to 400 K ohms. Overall size 7 × 5 × 2½in. **PRICE £14/14/-.**

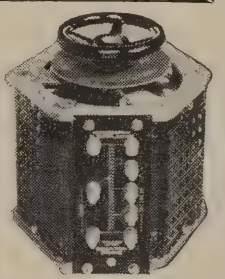
30,000 o.p.v. MULTI-TESTER MODEL 500 Ranges D.C. volts 0-1,000 v. A.C. volts 0-1,000 v. (15,000 o.p.v.). D.C. current 0-05 500 mA., 0-12 v. Resistance 0-60 megs. Decibel +20 to −56 dB. Sizes 3 5/16 × 6 5/16 × 2½in. **ONLY £8/17/6.**

20,000 o.p.v. MODEL C.T.500. Ranges D.C. Volts 0-5,000 v. A.C. Volts 0-1,000 v. (10,000 o.p.v.). D.C. Current 0-500 mA. Resistance 0-12K-120K-1.2M-12M. ohms (by 2 1.5 v. internal batteries). Decibels −20 to +62 dB. Sizes 5½ × 1½ × 3½in. **ONLY £5/19/6.**

3,300 ohms per volt. Model YP.60. Pocket size meter ideal for general use. Ranges D.C. volts, 6, 12, 60, 300, 1,200. A.C. volts, 6, 12, 60, 300, 1,200. D.C. amps., 300μA, 3 mA. 300 mA. Ohms, 0-30 K ohms, 0-3 M ohms, DB, −20 to +18 dB, 0 to +24 dB. Size, 4⅜ × 3¼ × 1¾in. **PRICE 52/6.** P.P. 2/-.

2,000 ohms per volt. Model Y.3. Sub-miniature in size and convenient in use. Ranges D.C. volts, 6, 30, 150, 500. A.C. volts, 6, 30, 150, 600. D.C. amps. 150 mA. Ohms, 0.100 K ohms. Sizes 3⅜ × 2½ × 1⅜in. **PRICE 39/6.** P. & P. 2/-. All complete with test leads, battery, instructions and fully guaranteed.

'POWERSTAT' VARIABLE TRANSFORMERS

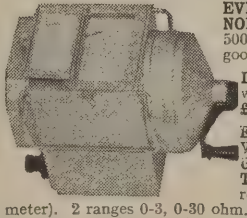


Input 230 volts. 50/60 cycles. Output 0-260 volts at 9 amps. Fully shrouded. For bench or panel mounting. A robust job of outstanding quality and performance. Brand new and guaranteed. **£15.** Carr. 7/6. Made in U.S.A.

AUTO TRANSFORMERS. Step up, step down, 110/115, 220/230 v. Fully shrouded terminal block connectors. 150 w. **32/6**; 300 w. **47/6**; 500 w. **67/6**; 750 w. **77/6**; 1,000 w. **90/-**; 1,750 w. **175/-.** Carriage 5/- on each type.

RCA PLATE TRANSFORMERS 190 to 250 v. primary 50-60 cycles. Secondary 1,500-0-1,500 v. or 2,000-0-2,000 v. at 500 milliamps. Brand new and boxed **£6/10/-.** Carriage extra.

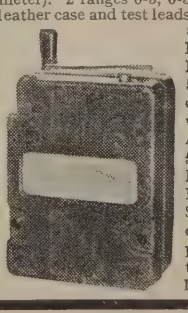
COSSOR 1035 DOUBLE BEAM OSCILLOSCOPE
A fine instrument in perfect condition and in good working order, **£37/10/-.** Carr. 30/-. Also 1049 at **£45.** Carr. 30/-.



EVERSHED & VIGNOLES Series II. 500 v. Megger in good cond. **£18/18.**

DITTO. NEW with leather case **£25.**

EVERSHED & VIGNOLES MEGGER CIRCUIT TESTER (low reading ohm meter). 2 ranges 0-3, 0-30 ohm. Complete with leather case and test leads. As new, **£6/6.** Ditto 0-500, 100-5,000 ohms **£6.**



EVERSHED & VIGNOLES. Wee Megger 500 w., with leather carrying case, good working order **£15.** Also 100 v., as above, **£6/6/-.**

BRIDGE MEGGERS. Evershed and Vignoles Series 2, 500 v. Accurate working order, perfect condition, fully tested. Complete with leather case, **£40.**

DON'T MISS THESE BARGAINS

Transistor ferrite rod aerial with medium and long wave coils with circuit. **7/6.**
Oscillator Coil and set of 3 I.F. transformers for transistor set with circuit. **12/6.**
Midget 3in. P.M. Loudspeaker 3 ohm, **12/6,** 8 ohm, **13/6.** Midget 208 pF+176 pF two-gang Tuning Condenser with trimmers for transistor set. **Price 9/-.**
Push-Pull Transformer. Sub-miniature, **8/6.** 0005 mfd. Single Tuning Condenser. Solid diaelectric ¾in. spindle for transistor of Crystal set, with spindle tapped 6 BA., **2/6.**
Zener diodes for voltage control and stabilisation. Complete with circuit diagram, **3/6** each.
Waterproof Heater Wire. 16 yd. length. 70 watts. Self-regulating temperature control, **10/-** post free.

Simmerstat Heater Regulator

Suitable to control elements, heaters, soldering irons and boiling rings up to 2,500 watts. Completely adjustable, normal price **55/-** each, special snip price **12/6,** plus 1/6 postage and insurance.

Refrigerator Thermostat

Standard type with adjustment for all normal refrigerator temperatures, **7/6.** Post 1/-.
Pre-Amplifier. Made to Mullard design to suit the 10-watt amplifier, made to specification. New unit. Simply needs valves. Type EF86, **37/6** each.
46 Sets (Receiver/Transmitter pack set). Unused sets complete except for crystals. **19/6.** Post 3/-.
Battery Charger Kit. Comprises 5 amp. transformer, 5 amp. rectifier, metal case and meter to charge 6 or 12 volt batteries up to 5 amps. With variable charge rate, **39/6** each. 3/6 post & insurance.
Mains Transformer. 250-0-250 at 80 mA. 6.3 volts 5 a. (normal mains input), **12/6** each. Carr. 2/6.
Output Transformer. Standard pentode matching type, **4/6** each; **48/-** per doz.
Vibrator Transformer. Suitable for 6 or 12 volts input, **5/9** each; **£3** per doz.
Slide Switch. Sub-miniature but dpdt, **2/6**; **18/-** doz.

T.C.C. or Dubilier Tubular Condensers.

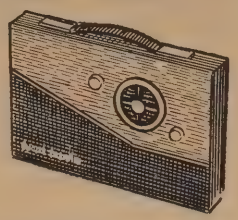
.5 mf. 500v.	10/- doz.
.25 mf. 500v.	7/6 doz.
.25 mf. 350v.	6/- doz.
.05 mf. 500v.	5/- doz.
.01 mf. 500v.	4/- doz.
.0001 mf. 1000v.	5/- doz.
.001 1000v.	6/- doz.
.002 1000v.	7/6 doz.
.005 1000v.	9/- doz.
.02 750v.	8/6 doz.
.01 1000v.	10/- doz.

Battery Charger Rectifier. Selenium 12-15 v. 5 amp. **9/6.**
Metal Chassis. Punched for Mullard 510 Amplifier, complete with inner screening sections and stove enamelled. **12/6** set.
Twin Twisted Lighting Flex. Equivalent 14/36, rubber insulated, cotton covered, **12/6** per 100 yard coil.
Moving Coil Meters

0-500 microamp, 2in. flush	17/6
250-0-250 microamp, 2½in. surface	27/6
750 microamp, 2½in. surface	17/6
0-30 milliamp, 2½in. flush	17/6
0-100 milliamp, 2½in. flush	15/-
0-300 milliamp, 2½in. flush	15/-
0-500 milliamp, 2½in. flush	15/-

Unbreakable Mains Lead. Type of lead fitted to electric razors makes fine lead for test meters and any other devices where subject to continuous bending. Twin figure eight construction, soft cream P.V.C. covered. Normally costs **2/-** per yard. Three 6ft. leads for **2/-.**
Filament Transformer, 6.3 v., 1½ amp. **6/6.**
Neon Lamp—midget wire ended, ideal mains tester, etc. **2/-.** Ex-Govt. **1/6.**
Philips Trimmers. 0-30 pF. **1/-** each; **9/-** doz.
Heavy Duty Test Prods—red and black with plug-in lead attachments, **6/6.**
Low Resistance Headphones. Ideal crystal sets, etc. **7/6,** plus 2/6.
Cold Cathode Valve CV 413. Voltage regulator or trigger switch—unused but ex-equipment. **2/-** each.
Tag Panels. Ideal for constructors, experimental circuits, etc. 3 of each of 12 different types, **5/-.** Post 1/6.
Slydlock Panel Mounting Fuses, with carrier, 5 amp. **2/-** each; 15 amp. **2/6** each.
.1 mfd. 350 v. Small tubular metal-cased condensers made by Dubilier, **2/6** doz.
5000 mfd. Condenser. 12 v. working, by Plessey, new and perfect. **2/-** each; **18/-** doz.
Toggle Switch. Standard metal body, type with round dolly, fixing ring and on/off indicating plate, **1/3**; or **12/-** doz.
Metal Rectifier. 250 v. 60-80 milliamps, ideal for mains set or instrument or to replace that expensive valve, **4/6.**
Long, Medium and Short Wave Coil Pack. An exceptionally well made coil pack which covers the standard long, medium and short wavebands for 465 kc/s. I.F. complete with diagram of connections, **14/6.**
Where postage is not definitely stated add 2/- to all orders under £3.

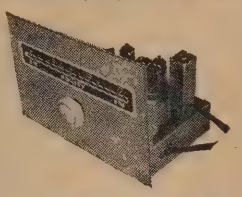
GOOD COMPANION Mark III



The 6-transistor set with the 8-transistor performance.
Incorporating all the latest refinements. Anyone who can solder can make it.
Many thousands already in use all over the country.
Full coverage of Long and Medium wavebands.
Fine looking cabinet, size 11×8×3in.
Q.P.P. output approx. 750 MW.
Excellent reception of difficult stations like 208.
Variable feedback, gives excellent tone.

ONLY **£5/19/6** plus 3/6 post.

F.M. TUNER



This is a high fidelity unit which although moderately priced has a performance equal to the highest priced: its stability is very good and extremely good results have been received with the simplest of aerials as far away as Eastbourne. The unit has its own power supply for A.C. mains. Less valves only **39/6** post & ins. Otherwise ready to use.

CABINET & PICK-UP

Made for a famous company intending to make a battery Record Player but changing their minds. This is an extremely fine looking cabinet, must have cost at least £2 to make. It is complete with handle and fasteners as illustrated. Also included in the parcel is a Cosmocord pick-up with crystal cartridge and sapphire stylus. Both items new and perfect.

ONLY 19/6 Plus 4/6 post and insurance

THIS MONTH'S SNIP

Complete kit of parts to build this transistor 2 wave receiver at only **39/6** plus 2/6 post & ins.

"CORONET" Mk. III

It fully covers the medium-wave band and that part of the long-wave band to bring in B.B.C. Light. The circuit includes a highly efficient slab aerial and Plessey tuning condenser. Overall size approximately 4½×2½×1½in. Supplied complete with carrying case.

YAXLEY SWITCHES

Full range still available as our advertisement last month.

MOTOR BARGAIN

Silent running mains motor by very famous maker. Ideal for gramophone, tape recorder, fan, etc. etc. 200-250 volts. A.C. shaded pull start. Size approximately 2¾ × 2½ × 1¾in., 2,750 r.p.m. Spindle diameter 5/32in. Spindle length ¾in. Brand new guarantee. Price **12/6** plus 1/- post.

DO YOU EVER FORGET?

This pocket Secretary could eliminate the trouble (often embarassment) your forgetfulness causes you—she will stay in your jacket pocket and as fast as you can think she will capture and store—ideas—notes—formulae—appointments—anything you can say or sing, then at your command she will play them back to you.

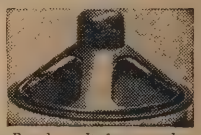
Undoubtedly one of the smallest precision tape recorders made. Entirely controlled by push buttons, you can record and play back with the instrument in your pocket. It is a full function machine using standard ¼in. tape and easy to replace batteries. Speaking and playing back is from the same (crystal) microphone.
Specification: Dimensions 6½ × 2½ × 1¼in., weight 14 oz.; recording times: 12 mins.; rewinding time, 4 mins.; recording system: D.C. Bias; erasing system: Magnetic erasing; wow and flutter: within 2% and frequency response: 500-1,200 c/s (within—6dB).

PRICE **£6/19/6** plus 3/6 post & ins. **Complete ready to work.**

Cabinet Snip

This fine cabinet as illustrated but less control knobs is available this month at a special snip price of **12/6,** plus 3/6 post and insurance Size is 3¾in. × 9in. × 4in. and it is nicely covered in two-tone I. C. I. fabric.

Speaker Bargain



12in. High fidelity loudspeaker. High flux permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new, by famous maker. Price **27/6,** plus 3/6 post and insurance.

MAKE A FAN

Miniature motor 2½in. long × 1¾in. diameter, laminated poles. Operates off 20-30v. D.C. Original cost at least £3 each. **8/6** plus 1/6d. postage and insurance. Mains model **9/6,** plus 2/6 postage and insurance.

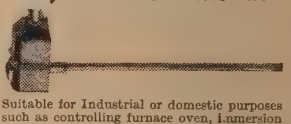
TRANSISTOR SET CASE

Very modern cream cabinet, size 5½ × 3 × 1¾in. with chrome handle, tuning knob and scale. **Price 7/6,** plus 1/6 postage.

FLOODLAMP CONTROL

Dim and full switch for controlling photo flood-lamps: Gives two lamps in series, two lamps full brilliance and lamps off. Similar control of other appliances. With circuit **3/6,** plus 9d. postage.

Adjustable Thermostat



Suitable for Industrial or domestic purposes such as controlling furnace oven, Immersion heater, etc. Can also be used as a flamestat or fire alarm. Made by Sunvic these are approximately 17in. long and adjustable over a range 0 to 550°F. The contacts are rated at 15 amps. 230 volts, and the adjustment spindle, which comes to the top, can be fitted with a flexible drive for remote control or just a pointer knob for local control. Listed at **£3** or **£4** each, these are offered only at **8/6,** plus 2/6 postage and insurance.

Morganite Potentiometers

Single and 2-gang types available, standard size with good length spindle, all new. **Single types 1/-** each, values available: 5K, 50K, 100K, 250K, 2 meg. **Gang type 3/-** each, values available: 5K + 5K, 100K + 100K, 10K + 10K, ½ meg. + ½ meg. 2 meg. + 2 meg.

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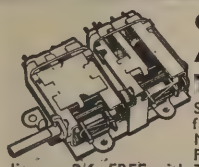
BARGAINS TO SEE FROM R & TV



CYLDON A.M./F.M. PERMEABILITY TUNER FOR ALL TRANSISTOR OPERATION

Size 2½in. x 2¼in. approx. By famous manufacturer. A.M.-I.F. 470 Kc/s. F.M.-I.F. 10.7 Mc/s. A.M. coverage from 1,620 Kc/s.-525 Kc/s. F.M. coverage 108 Mc/s.-88 Mc/s. Circuit diagram 2/6. FREE with Tuner 25/–. 1st, 2nd, 3rd A.M.-I.F.'s 12/6 set. 1st, 2nd, 3rd and 4th F.M.-I.F.'s 12/6 set. V.H.F. Osc. choke 1/–. A.M.-I.F. trap 1/6. A.F. 114 and A.F. 115 5/– each. All the above are the R.F. end of an AM/FM receiver car radio etc. The above six items purchased together **£2 . 10 . 0**

BSR MONARCH UA14 with FUL-FI HEAD

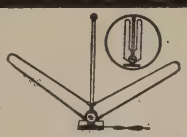
4-speed, plays 10 records, 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position: colour, brown. Dimensions: 12½ x 10¾in. Space required above baseboard 4½in., below baseboard 2¾in. Fitted with Ful-Fi turnover crystal head, **£5/19/6.** P. & P. 6/6.

B.S.R. UA16, similar to the above, **£6/12/6.** P. & P. 6/6.

B.S.R. GU7, 4-speed, single player, complete with pick-up on uniplate with automatic switch. **£3/19/6.** P. & P. 5/6.

625 INDOOR AERIAL

625 line indoor aerial complete with stand, fully extendible, can also be used for 405 ITV, BBC and FM. **19'6** Plus 1/– P. & P.

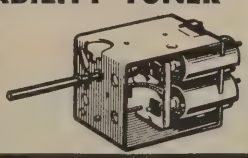


FLUORESCENT LIGHT KIT

40 watt fluorescent lighting kit comprising Siemens Choke, 2 Bi-pin holders, Starter Holder and Starter. **11'6** Plus 3/– P. & P.

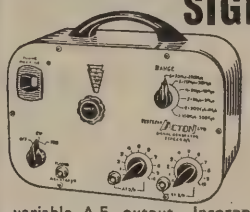
CYLDON PERMEABILITY TUNER

Medium and long wave Tuner. Size 3" × 2" × 1¾" approx. Coverage 190-540 meters, 1250-2000 meters I.F. 470 Kc/s, Price **19'6** P. & P. 1/6.



PRESS-BUTTON COIL PACK. Medium and 2 shorts. Complete with twin-gang tuning condenser and ferrite rod aerial. **19/6,** plus 2/6 P. & P. Circuit diagram 2/6. FREE with pack.

SIGNAL GENERATOR



Covering 100 Kc/s.-100 Mc/s. on fundamental and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. x 6¾in. x 5¼in., grey hammer finish. Incorporating three miniature valves and metal rectifier. A.C. mains 200/250 v. Internal modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F. output continuously variable, 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%. **£7/5/0** Post and packing 6/6 extra.

MAINS TRANSFORMERS

ALL WITH TAPPED PRIMARIES 200/250 VOLTS

250-0-250 v. 60 mA., 6.3 v. 1.5 amp., 6.3 v. 1 amp	11/6
250-0-250 v. 80 mA., 6.3 v. 1.5 amp., 6.3 v. 1 amp	15/–
250-0-250 v. 50 mA., 6.3 v. 2 amp	9/6
250-0-250 v. 250 mA., 6.3 v. 5 amp.	19/6
Heater Transformer 6.3 v. c.t. 2 amp	7/6

Postage and packing on all the above transformers 4/–.
Primary 230-240 v., Secondary 330-0-330 v. 200 mA., 6.3 v. c.t. 6 amp., 5 v. 4 amp. 21/–. P. & P. 6/–.

POCKET MULTI-METER. Size 3⅞ x 2½ x 1⅜in. Meter size 2½ x 1⅜in. Sensitivity 1,000 P.O.V. on both A.C. and D.C. A.C. and D.C. volts 0-15, 0-150, 0-1,000. D.C. current 0-150 mA. Resistance 0-100KΩ. Complete with test prods, battery and full instructions. 35/–. Plus 1/6 P. & P.

50 MICRO-AMP. METER Movement by world-famous manufacturer. Size 3in. x 2¾in. 50/– post free.

THE MOTORIST'S REV. COUNTER

Kit of parts comprising 270 degree 3in. moving coil movement. Manufacturer's present price of this movement would be at least £7. Complete with full instructions and circuit diagram. Scale calibrated up to 8,000 r.p.m. Can be used with any 4 or 6 cylinder car. Meter movement only 22/–, post paid. **29'6** Plus 3/6 P. & P.

FIXED FREQUENCY SIGNAL GENERATOR

Crystal control in metal case, size 10in. x 6in. x 6in. Incorporating 2 FC13 valves, mains transformer, metal rectifier, choke, indicator lamp, crystal and numerous components. Modulated and unmodulated output sockets. Originally used for I.T.V. frequencies. Brand new. 39/6 + 6/– P. & P. A.C. Mains 200/250 volts.

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THE *"Elegant Seven"*

COMBINED PORTABLE & CAR RADIO

THE RADIO WITH THE "STAR" FEATURES

- ★ **7-transistor superhet. Output 350 mW.**
- ★ **Two-tone grey wooden cabinet, fitted handle with silver-coloured fittings, Size 12¼in. × 8¾in. × 3¼in.**
- ★ **Horizontal tuning scale, size 11¼in. 2¾in. in silver with black lettering.**
- ★ **All stations clearly marked.**
- ★ **Ferrite-rod internal aerial.**
- ★ **IF 470 kc/s.**
- ★ **Operated from PP9 battery.**
- ★ **Fully comprehensive instructions and point-to-point wiring diagram.**
- ★ **Printed circuit board, back-printed with all component values.**
- ★ **Fully tunable over medium and long waveband.**
- ★ **Car-aerial socket.**
- ★ **Full after-sale service.**

Parts list and circuit diagram 2/6. FREE with parts. 4½" speaker also available 7/6 extra.

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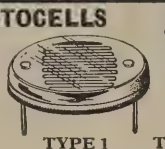
CADMIUM SULPHIDE PHOTOCELLS



New, inexpensive photo-conductive cells which act as light-sensitive resistors that increase conductivity with increased light. These are 1,000 times more sensitive than selenium cells, with greater reliability, and can easily be built into a wide range of simple circuits. Typical uses include automatic light controls for home and car flashing barricade or breakdown lights, exposure meters, brightness controls, relay operation, and many other devices. Require only simple low power source from battery or mains transformer. Two types available.

TYPE 1.—**Max. voltage 200 v. Output 0.5 W.** **10/-** *post free.*

TYPE 2.—**Max. voltage 150 v. Output 0.15 W.** **8/6** *post free.*

Both types have a resistance range of 5 megohms at zero to 500 ohms at 1000 lux. Sensitive range is 400-800 mu. Supplied with specification, instructions and typical circuits.

DIFFRACTION GRATING REPLICA

Teaches Science, Creates Unique Photography, Beautifies Possessions

Long known to science, but hitherto costing £2 per sq. in. and available in small pieces only. Basically transparent film embossed by special process with 13,400 parallel grooves per inch, but also supplied backed with mirror-bright aluminium. Phenomenon of diffraction creates incredibly beautiful rainbow effects when exposed to natural or fluorescent light. **Can be used for making spectroscopes, out-of-this-world colour photography, accurate microscope specimen measurement, astronomical uses and also to provide really dramatic effects in home decoration, display, artistic mobiles and myriad other uses.** Two types available: **Transmission**—crystal clear. **Reflection**—mirror backed. Each supplied in 10in. × 8in. sheets complete with full use Ideas Booklet. **Transmission: 10/-** *Post free* **Reflection: 17/6** *Post free* Any length (8in. wide) supplied pro rata.

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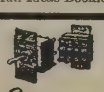
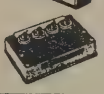
Quite small pieces of Grating can be used for making simple spectroscopes, many photographic applications, teaching interest, etc. Two Transparent pieces and one Reflection piece can be supplied in standard 35 mm. slide mounts together with full Ideas Booklet for only **5/-** *Post free*





SWITCHES *Wide variety of types*

1. Four-pole Changeover. 4-pole, 3-way (Centre OFF) panel switches by Cutler-Hammer. Size overall: 1⅜in. × 1⅛in. × 2⅛in. high. Very conservatively rated at 7-10 amps. per contact at 250 v. A.C. A first-class control switch for domestic fires, instrument panels, etc. **2/6** *Post free*

2. Aircraft Pattern Roller Actuated Microswitch with beryllium copper leaf contacts. Rated 3 amps. at 230 v. A.C. Can be connected for "Normally on" or "Normally off" as required. Case size: 1⅛in. × 1⅛in. × ⅝in. thick. **3/6** *P. & P. 1/-*

3. Four-way Switch Block. Four toggle switches in flat base, moulded plastic box with connector block. Size: 3in. × 4⅛in. × 1in. Makes an extremely neat looking control box. **SEND FOR COMPLETE SWITCH LIST.** **3/6** *P. & P. 1/6*

HIGH POWER MAGNETS

For Experimenters, Education, etc.

HORSESHOE MAGNET. Alcomax III Magnet. Complete with keeper, finished durable red crackle. Lifts 9 lbs., or about seventy times its own weight. Size overall ⅞in. wide × ⅝in. × 1in. high, **4/-.** *P. & P.* 9d.

LIMPET MAGNETS. Type 1.—Feroba. A powerful ceramic magnet contained in black enamelled mild steel case that will retain its full power in a lifetime of use. Lifts a tremendous 65 lbs., 3⅛in. diam. × ⅝in. thick. Does not require keeper. **12/6.** P. & P.1/-

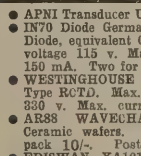
Type 2.—Hycomax II. Size only 1⅛in. diam. × ⅛in. thick, but made of fantastic new material that provides a lift of 45 lbs.! Finished in grey crackle and complete with keeper. Drilled centrally to take lifting screw, **8/-.** P. & P. 1/-.

BAR MAGNETS. Made of Hycomax II and easily the most powerful Bar Magnets for their size available. Will lift 3½ lbs. Size only ¼in. sq. × 2in. long. Ideal for demonstration. **5/- per pair.** *Post paid.*

ELECTROMAGNET. Powerful unit specially made for Proops for demonstration purposes, educational and experimental use. Operates from 12 v. D.C. and continuously rated to lift ¾ lb. Size overall: 1 13/16in. dia. × 1⅛in. high and tapped 4 BA at top to facilitate permanent mounting Magnet contact area 1⅛in. dia. **8/6.** *P. & P.* 1/-.

MINIATURE SUBMERSIBLE WATER PUMP 10/6 *Post free*

For Aquaria, Table Fountains, Plant Humidity Control



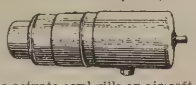
Totally enclosed in durable, non-corrodible case, only 2⅛in. long × ⅞in. dia. Weight 1½ ozs. **Self-priming but runs totally submerged and will pump 1 pint per minute at 1ft. head. Operates from 8-16 v. A.C.—absolutely safe, trouble-free supply that can be provided from the inexpensive transformer listed below. Complete with spare valve and spring and fitted with 27in. leads.**

STEP-DOWN TRANSFORMER 7/6 *Post free.*

Works from any 200-240 v. A.C. mains supply and provides output of 15 v. at 1 a. Size 3⅛in. × 2⅛in. × 2⅛in. high.

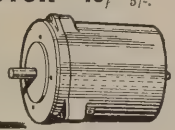
- **APNI Transducer Unit, 8/6.**
- **IN70 Diode Germanium Point Contact Diode, equivalent OA85. Max. reverse voltage 115 v. Max. forward current 150 mA. Two for 2/6.**
- **WESTINGHOUSE SILICON DIODE. Type RCTD. Max. P.I.V. 1,000 R.M.S. 320 v. Max. current 500 mA. 7/6.**
- **AR88 WAVECHANGE SWITCHES. Ceramic wafers. Unused in original pack 10/-.** Post and Packing 1/6.
- **EDISWAN XA101 TRANSISTOR (equivalent Mullard OC45) two for 6/-.**
- **FILAMENT TRANSFORMERS. High quality drop-through type. Size: 3 × 2⅛ 3⅛in. deep. Input: 200/250 volts A.C., 50 cycles. Output: 6.3 volts centre tapped at 4 amps. New and guaranteed. Tremendous bargain offer, only 5/-.** Post and packing 2/-
- **120 VOLTS NEON M.B.C. Single base contact. Six for 7/6.** Post free.
- **MAINS NEON S.B.C. Twin base contact. Ten for 17/6.** Post free.
- **PIEZO CRYSTAL complete element with ribbon contact leads, ten for 12/6.**

ANTENNA BEAM ROTATING MOTOR 55/- *Carr. 7/6.*



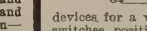
Magnificent series wound, split field motor which is ideal for beam rotation, winch operation, etc. Extremely robust unit incorporates a 600 to 1 epicyclic gearbox (output speed 12/15 r.p.m.) and a magnetic brake to prevent overrun, together with limit switches which allow rotation of approximately 3 turns in either direction. Originally designed for use on 24 volt D.C. to actuate cowl gills on aircraft, but limit switches can be disconnected to provide continuous running in either direction and removal of magnetic brake enables unit to be operated on any voltage between 6 and 30 volts A.C. or D.C. Size overall 12 × 3⅛in. diam. with ¼in. diam. splined driving shaft × ⅜in. long. Current consumption: 4 to 6 amps. at 24 volts D.C. **Excellent Guaranteed Condition.**

1/6 H.P. REVERSING MAINS MOTOR 40/- *Carr. 5/-.*



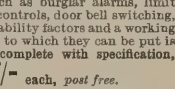
English Electric 1,440 r.p.m. Wt. 16lb. Totally enclosed capacitor start type employing heavy die-cast construction. Suitable for flange mounting vertically or horizontally by tapped holes in integral mounting flange. Size overall (less spindles): 5⅛in. long × 4⅛in. dia. Fitted with ⅝in. dia. by 1⅛in. long drive shaft at front and ⅛in. dia. × ⅜in. long drive shaft at rear. **With capacitor and instructions.**

DRY REED SWITCHES



Basically a pair of gold diffused reed contacts hermetically sealed in a glass tube filled with inert gas. Contacts can be actuated by permanent or electromagnets and so form ideal devices for a wonderful range of inexpensive devices such as burglar alarms, limit switches, position indicators, r.p.m. counters, night light controls, door bell switching, level controls, etc., etc. Reed switches have tremendous reliability factors and a working life of about 100 times that of micro-switches, and the uses to which they can be put is limited only by imagination. **Each switch is supplied complete with specification, instructions and ideas information.** *Suitable magnets 1/- extra.* **7/-** **each,** *post free.*

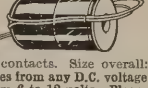
REED SWITCH COILS 4/- *Post free.*



Specially manufactured to provide electro-magnetic operation of Dry Reed Switches. Coil is simply pushed over glass tube envelope of switch and located round switch contacts. Size overall: 1⅛in. diam. × ⅝in. long. **Two types are available: Type 1—operates from any D.C. voltage from 1½ to 6 volts; e 2—operates from any D.C. voltage from 6 to 12 volts. Please state type required when ordering.**

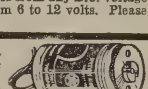
CONTROL TRANSFORMER

TYPE 810226. Made by Hughes Aircraft Corp. Stator 11.8 v. Rotor 23.2 v. Mounting flange diam. 1in. Length 2⅛in. Shaft length ⅝in. diam. 0.12in. Complete with flying leads. **50/-** *Post free.*



SYNCRO RESOLVER

TYPE R235-1-A. Made by Kearfott, U.S.A. Rotor 2-phase, 26 volts, 400 c/s. Stator 11.8 volts, 2-phase 400 c/s. Mounting flange 1in. diam. Length 2in. Drive shaft diam. 0.12in. **50/-** *Post free.*



CONTROL MOTOR

TYPE R110-2B-B. Made by Kearfott, U.S.A. 2-phase, 400 c/s input which can be 115 volts to each phase, or 115 volts to ph-1, and 57.5 volts to ph-2. Length overall 2⅛in. Mounting flange diam. 1⅝in. Shaft diam. 0.175in. **50/-** *Post free.*

VITAMIN "Q" CONDENSERS

Much sought after, high-grade condensers which are often specified in really important equipment where possible malfunction must be kept to an absolute minimum. Vitamin "Q" condensers look superficially like miniature tubular types but are glass sealed, oil-impregnated, non-polarized, and brass encased. They withstand tremendous extremes of heat and humidity, shock and vibration. At least 50 useful values on two component boards removed intact from ultra-modern, unused American radar equipment and guaranteed perfect. Values range from 0.0015 mfd. to 2 mfd. and voltage ratings up to 600 volts D.C. **10/-** *Post free*

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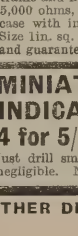

DIRECT READ-OUT TUBES

XN3 "Numicator" read-out indicators scaled 0-9 and for operation from 180-300 volts D.C. Unit is contained in cylindrical glass envelope size ⅝in. diam. × 1⅛in. high with wire-ended connections. Figure height ⅛in. Can be used in single circuits to give numerical indication or to form basis for electronic counters with speeds up to 5 kc/s. New current production complete with specification, performance data and typical circuits. **£1.10.0 each**

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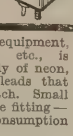
SENSITIVE RELAY 5,000 OHM COIL 12/6

P. & P. 1/-.



2-Pole Changeover. Contains twin coils wound in series on a sintered frame and fitted with leaf spring operated silver contacts. Coil resistance 5,000 ohms, nominal voltage 26.5v. D.C. Contact capacity 2A. In metal case with integral mounting screws and glass sealed hook-on contacts. Size 1in. sq. × 1⅛in. high. **Removed from unused ultra-modern equipment and guaranteed serviceable.** Send for Complete Relay list.

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Give positive indication that equipment, tools, instruments, apparatus, etc., is switched on. Complete assembly of neon, resistor, insulation and flying leads that requires only connection to switch. Small size and insulation permit simple fitting—just drill small hole in panel or tape or clip to equipment. Current consumption negligible. New manufacture.

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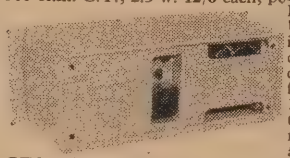
WHEATSTONE BRIDGE in a beautiful oak case centre zero galvanometer 2.5 mA., 4 stud switches, 0-10, 0-100 ohms, 0-inf., size 16 × 7½ × 6in., 45/- each, 5/- post.
DE-ICER, Controller Mk. 3. Contains 10 relays D.P. change-over heavy duty contacts, 1 relay 4P, C/O (235 ohms coil). Stud switch 30 way relay operated, one five way ditto, D.C. timing motor with Chronometric governor 20-30 volts 12 RPM, geared to two 30-way stud switches and two Ledex solenoids, 1 delay relay, etc., sealed in steel case, size 4 × 5 × 7in., £3 each, post 5/-.
BC640 MODULATOR UNIT. 2 ×811's, mod. transformer and fil., trans. complete mod. unit fits 19in. rack 50 watts, **£5/10/-.** carr. £1.
TRANSFORMERS (Isolation), 230 to 115 volts 300 va., £3 each, 5/- post. 230-115 volt auto. 750 watts £4, carr. 10/-. 110-230, 275-0-275 at 125 ma., 6.3 at 4 amps. 22/6 each, post 5/-. 230 v. 6.3 v., x 3 at 3 amps. 21/- each, post 4/-. 230 v., pri. 1850-0-1850 at 500 ma., £5 each, carr. 15/6. 230 v., pri. 6.3 x 3 at 3 amps. 20/- each, post 4/-. Pri., 110/230 v. input 7.5 v. at 4 a., 2.5 v. at 5 a., 7.5 v. at 8 a., 6.3 v. at 4 amp., 25/- each, 5/- post. 230/115 v. auto. 300 va. £2, post 6/6.
TCS MODULATION TRANSFORMER 20 w. Pri., 6,000 ohm. C.T. Sec., 6,000 ohm. 25/- each, post 3/6. **MICROPHONE TRANSFORMER** Pri., 75 ohm. Sec., 125,000 ohm. 10/- each, post 2/6. **OUTPUT TRANSFORMER.** Pri., 7,500 ohm. Sec., 500 ohm. C.T., 2.5 w. 12/6 each, post 3/-.



POWER & SMOOTHING UNITS. 100-250 v., A.C. input 24 v., D.C. at 3 amps. or 12 v. twice at 3 amps., continuous rating, switched fused, etc. In metal case 19 × 7 × 7in. Smoothing two large chokes and 0-1 ma. meter scaled 0-50 volts. £7/10/- (pr.), 15/- carr.
GEARED MOTOR. 24 v. D.C., 1.4 r.p.m., reversible with two micro switches inside gear box, silent operation, £2 each, post 5/-.
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TUBES. 5CP1a 30/- each, post 3/-. 3BP1 25/-, post 2/6. 814 17/6, post 2/-. VT4C 17/6, post 2/-. CV1526, 25/-, post 2/-. VT158, 50/-, post 3/-. CV370, £3, post 4/-. 4J50, £10, 807s, 8/6 each, post 2/6. 5U4G 6/6, post 2/6. 5Z4, 8/6, post 2/6. CV128, 25/-, post 3/-.
SIGNAL GENERATORS. TS-13AP freq. 9305-9445 mc/s., £25 each, carr. £1. 10 cM, BC1277 £20, carr. 25/-. RCA 710A 370-560 mc/s. £30, carr. £1. TF 144G 85 Kc/s. to 25 mc/s. £25, carr. 25/-. Test set UPM 1a and b comprising of Signal Generator, Wavemeter, Oscilloscope and Video amp., in one unit freq., 155/235 mc/s. and 460-570 mc/s., 115 and 230 v. A.C., new £35 each, carr. £2. Type 804 freq. 7.5-330 mc/s. 115 v. A.C. £25 each, carr. £1. TS-12/AP Standing Wave Indicator Equipment £12/10/-, carr. 15/-. TS-34 Portable Single Beam Oscilloscope 115 v. A.C. £15 each, carr. 15/-. TS-36/AP Power Meter with accessories, £5 post 10/-.

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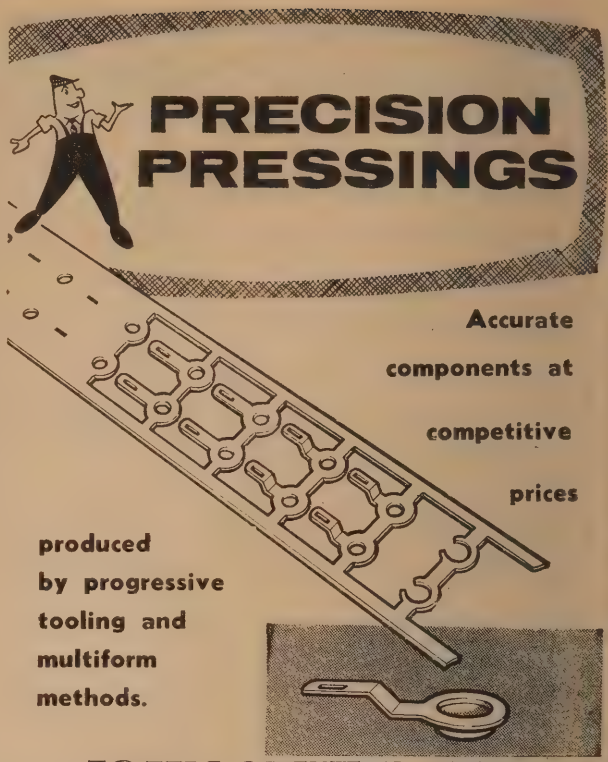

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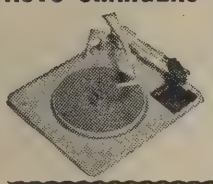

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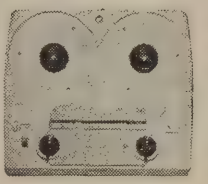
MODEL R7 BY WELL-KNOWN BRITISH MANUFACTURER



Two speeds—3¾ and 7½ i.p.s.; three high quality motors. Will record and replay **IN BOTH DIRECTIONS.** Fast forward and rewind. Supplied less heads, space is provided for fitting 4 heads of any type, to give full working in both directions on either 1, 2 or 4 track. Unit plate size 13 × 15in., depth below top of plate 5½in. Will take 7in. spools. Tape position counter fitted. For 200-250 volt 50 c.p.s. mains. Two-tone grey finish. Perfect order. Supplied less heads.

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Size for Models A and B: 14¼ × 14 × 6½in. Size for Models C & D: 14 × 12½ × 6½in.

MODEL A Studio Deck. Four Track. Speeds: 1⅞, 3¾ and 7½ i.p.s. Spool capacity: 7in. Wow and flutter: Less than 0.15% total. Playing Times: up to 18 hours. Frequency Response: 12,000 c.p.s. at 7½ i.p.s. Mains Voltage: 200-250 v. 50 c/s A.C. Output 3 watts.
LASKY'S PRICE **27 GNS.** Carriage and Insurance 15/- extra.

MODEL B Studio Deck, Two Track. Specification as for Four Track model above, except that this is fitted with Two Track Studio Tape Deck. Maximum Playing Time: up to 9 hours from one reel of tape.
LASKY'S PRICE **25 GNS.** Carriage and Insurance 15/- extra.

MODEL C Fitted with B.S.R. Deck, two-track version. Specification: Single speed, 3¾ i.p.s. Freq. response 10,000 c.p.s. at 3¾ i.p.s. Spool capacity: 5½in. Mains voltage: 200-250 v. 50/60 c/s. A.C. Wow and flutter: Less than 0.2% total. Output: 3 watts. Playing time: up to 3 hours.
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MODEL D Fitted with B.S.R. Four Track Deck—otherwise same specification as the Model C—but maximum playing time increased up to 6 hrs.
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7 transistor plus 2 diode superhet, 6 waveband portable receiver. Operating from four 1.5 torch batteries.

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The SKYROVER

Controls: Waveband Selector, Volume Control with on/off Switch, Tuning Control. In plastic cabinet, size 10 × 6¼ × 3¼in with metal trim and carrying handle. Can be built for **£10.19.6** Post & Pkg 5/- extra.

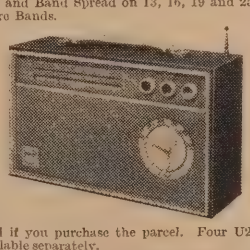
H.P. Terms: 22/- deposit and 11 monthly papments of 21/-

SPECIFICATION:

Superhet, 470 Kc/s. All Mullard Transistors and Diode. Uses 4-U2 batteries. 5in. Ceramic Magnet P.M. Speaker. Easy to read Dial Scale. Band Spread Tuning. 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial.

WAVEBAND COVERAGE: 180-576M; 31-94M and Band Spread on 13, 16, 19 and 25 metre Bands.

The SKYROVER De Luxe



Tone Control Circuit is incorporated, with separate Tone Control in addition to Volume Control, Tuning Control and Waveband Selector. In a wood cabinet, size 11½ × 6¼ × 3in. covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can be built for **£12.19.6** P. & P. 5/- extra.

H.P. Terms: 26/- deposit and 11 monthly payments of 24/-

Data for each receiver: 2/6 extra. Refunded if you purchase the parcel. Four U2 batteries included FREE. All components available separately.

Can be built for

£5 . 19 . 6

P & P. 4/6.

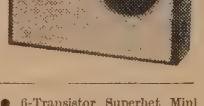
REALISTIC SEVEN

Fully tunable long and medium bands. Uses 7 Mullard Transistors; plus Diode OA70.

STAR features:

● 7 Transistor Superhet. ● 350 Milliwatt output 4in. high flux speaker. ● All components mounted on a single printed circuit board, size 5½in. × 5½in. in one complete assembly. ● Plastic cabinet, with carrying handle, size 7in. × 10in. × 3½in., in blue/grey. ● Easy to read dial. ● External socket for car aerial. ● I.L.frequency 470 Kc/s. ● Ferrite rod internal aerial. ● Operates from PP9 or similar batt. ● Full comprehensive data supplied with each Receiver. ● All coils and I.F.s, etc., fully wound ready for immediate assembly. An outstanding Receiver.

REALISTIC SEVEN DE LUXE



By popular request a De Luxe version of the well-proven Realistic Seven now available. With the same electrical specification as standard model—PLUS A SUPERIOR WOOD CABINET IN CONTEMPORARY STYLING covered in attractive washable material, with super-chrome trim and carrying handle. Also a full vision circular dial, externally mounted to further enhance the pleasant styling. **ONLY £1 EXTRA**

Battery 3/9 extra. (All components available separately.) Data and instructions separately **2/6**, refunded if you purchase parcel.

CAN BE BUILT FOR

79/6

P.&P. 3/6 extra.

THE SPRITE

● 6-Transistor Superhet Mini Personal Pocket Radio. ● Long and Med. wavebands. ● Uses PP3 batt. ● Ferrite Rod aerial. ● I.F. Freq. 470 Kc/s. ● 3in. speaker. ● Printed circuit 2¼in. × 2¼in. ● Slow motion Drive, ● Plastic case, size 4in. × 2¼in. × 2in.

In order to ensure perfect results, the SPRITE is supplied to you with R.F. and I.F. stages. Driver and Output stages, ready built with all components ready mounted on the printed circuit. The SPRITE pre-assembled plus cabinet, speaker and all components for final construction. **CAN BE BUILT FOR 79/6.** Post and pack, 3/6 extra. Data and instructions separately, **2/6.** (Refunded if parcel is purchased.) **Real calf leather case, wrist strap, personal earphone, case for earphone and battery, 12/6** the lot extra.

Make no mistake—this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.

THE PETIT FULMITER

Designed to replace PP3 9 v. battery. Operates direct from 200-250 A.C. Same size as PP3. **18/6** P. & P. 1/6.

READY BUILT RADIOS

Many more ready built bargains in stock.

BOY'S 2 TRANSISTOR POCKET RADIO

In attractive plastic case. Size only 4in. × 2¼in. × 1in. Fitted with 2¼in. loudspeaker. Socket for personal earpiece and telescopic aerial. Works from single PP3 type battery. Fully tunable over full medium waveband. Supplied complete with earpiece, telescopic aerial, carrying purse and 9-volt battery. Ideal Birthday present.

LASKY'S PRICE 42/- POST FREE with all accessories

6 TRANSISTOR POCKET RADIO

Fully built-in, plastic case, 4in. × 2¼in. × 1in. with 2¼in. speaker. Uses single PP3 type battery. Supplied complete with personal earpiece and leather case. Tunable over full medium waveband.

LASKY'S PRICE 69/6 POST FREE complete with all accessories

TAPE RECORDERS

FULLY TRANSISTORISED

THE CLARION "PHONOTRIX" A fully transistorised battery operated recorder. With leather case. **16 GNS.** Carr. 7/6.

Very Latest "PHONOTRIX" with push-pull output. Carr. 7/6. **20 GNS.**

CLARION "TWINSET" Transistor amplifier with 7in. × 4in. speaker in a portable case. The Clarion Phonotrix recorder can be housed in the case with the amplifier, this giving full quality output. Listed at 8 gns. **7 GNS.** P. & P. 5/-.

THE "MINY" A self-contained Transistor Battery Recorder. Size only 8 × 7¼ × 2¼in. Weight 3¼lb. Takes 3in. spools, twin track, 3¾ i.p.s. With tape, mic. and batterics. **7½ GNS.** P. & P. 5/-.

THE "TRAV-LER" Transistorised Portable Recorder. Full details as previously advertised Wireless World (Jan. '64). Last few available. **LASKY'S PRICE 13 GNS.** Carr. & Ins. 17/6 extra.

THE "CONET"

Fully transistorised 2 speed Battery Tape Recorder. ★ Capstan drive. ★ 2 speeds, 3¾ and 1⅞ i.p.s. ★ Fast rewind. ★ Twin tracks. ★ 2½in. speaker. ★ Accessories included: Leather carrying case, Microphone, Telephone adaptor, Personal earphone. **LASKY'S PRICE 19 GNS.**

Optional Extras. Remote Control Mic. **35/-.** Remote Control Foot Switch **25/-.**

ALL the above items are fully described on our "Bargain Bulletin"—sent FREE on request.

CONSTRUCTORS BARGAINS

NEW SUPER MINIATURE POCKET RADIOS

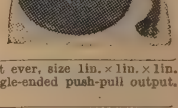
THE SINCLAIR SLIMLINE The new 2-transistor pocket radio size only 2¼in. × 1⅝in. × 1⅛in. Micro alloy transistors and printed circuit. Easy to assemble.

CAN BE BUILT FOR 49/6 All components available separately.

THE SINCLAIR MICRO-6 Self-contained pocket radio—size only 1⅝" × 1 5/16" × ½"!

CAN BE BUILT FOR 59/6 Mercury cell 1/11 extra.

STAAR KINDER RECORD PLAYER



45 r.p.m. 6 v. Batt. operated. Complete with pick-up fitted crystal cartridge. Size only 7½ × 6in. Fitted auto. stop and start. New and perfect. Suitable for use with both the listed below amplifiers.

LASKY'S PRICE 49/6 P. & P. 2/6.

NOW IN STOCK—2 speed model for 33⅓ and 45 r.p.m. 69/6 P. & P. 2/6

NPN-PNP Transformerless Transistor Amplifier. Smallest ever, size 1in. × 1in. × 1in. Output 125 MW from 9 v. batt. Uses 3 transistors. Single-ended push-pull output. Fully assembled. **LASKY'S PRICE 29/6.** Post 2/6.

300 m/w OUTPUT AMPLIFIER. Uses 2 OC71 and 2 OC72. Vol. and tone controls. Fully assembled, size 3 × 2 × 2in. **LASKYS' PRICE 39/6.** Post 2/6. Knobs 3/6 extra. Speaker 30 ohm 5 inch. Matched to amplifier **25/-.** Post 1/6.

TRANSISTORS

ALL BRAND NEW AND GUARANTEED

GET 81, GET 85, GET 86 **2/6**; 837A, 874P **3/6**; OC45, OC71, OC81D **4/6**; OC 44 OC70, OC 76, OC 81 (match pair **10/6**) **5/6**; AF 117, OC 75, OC 170, OC 200 **6/6**; OC 23, OC 42, OC 43, OC 73, OC 82D **7/6**; OCP 71 **9/6**; OC 201, OC 204 **15/-**; OC 205, OC 206 **19/6**; OC 28 **24/6**.

MINIATURE EARPIECES for Transistor Radios, Transparent

ear inserts with 3ft. cord, sub-min. jack and socket. Fully guaranteed. Post free.

CR.5	Crystal high imp.	5 0
MR.4	Magnetic low imp.	6 6

TRANSFILTERS By BRUSH CRYSTAL CO. Available from stock.

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TO—01D 470 kc/s. ± 2 kc/s.	TF—01B 465 kc/s. ± 2 kc/s.
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6/6 EACH P. & P. 6d.

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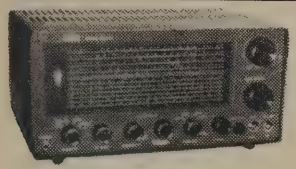
LASKY'S RADIO



COMMUNICATION RECEIVERS MODEL HE30/JN101

BRAND NEW AND UNUSED

Covers range from 540 Kc/s to 30 Mc/s. Ham Band is provided with a scale for direct reading, and can also be band spread. Facilities: A.N.L. A.V.C. and M.V.C. Q Multiplier also serves as B.F.O. H.F. stage and two I.F. stages ensure high sensitivity and selectivity. Valve line up: 3 × 6BA6, 2 × 6BE6, 2 × 6AV6, 1 × 6Q5 and 5Y3. 2 Aerial Sockets. Stand-by position for use with a transmitter. S meter fitted. 200-250 v. A.C. mains. Brand new and unused. Boxed with full instruction manual, in attractive steel cabinet, grey crackle finish. Cabinet size 15 × 8 × 10in. Dial 12 × 4in.
Carriage and Packing Free.

LASKY'S PRICE 40 GNS.

H.P. Terms: £4.4.0 deposit and 11 monthly payments of £3/16/0. Also available as a Kit—write for details.

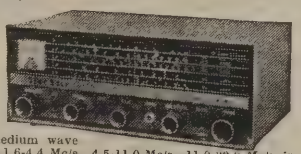
MODEL HE80

14-valve super sensitive communication receiver. Freq. range 540 Kc/s—30 Mc/s and 144-146 Mc/s. Dual conversion on 2 metres, with extra R.F. stage, Single R.F. stage, two I.F. stages on all other bands. B.F.O. and Q-multiplier circuits. Improved A.N.L. and voltage regulated powerpack. "S" meter, band spread on amateur bands, large illuminated dial with logging scale. All controls fitted. Outputs for speaker and phones. Valve line-up: 4 × 6AQ8, 3 × 6BA6, 2 × 6BE6, 1 × 6BL8, 6AL5, 6AQ5, 6CA4 and OA2. Steel case 17 × 7½ × 10in. For 200/250 v. A.C. mains. Brand new and boxed with full instruction manual.

LASKY'S PRICE 59 GNS. Carriage and packing free

H.P. TERMS available.

MODEL HE40



Covers medium wave band and 1.6-4.4 Mc/s., 4.5-11.0 Mc/s., 11.0-30.0 Mc/s. in separate switched band spread ranges, Controls include B.F.O. Sensitivity, A.N.L., Receiver-Stand-by Switch, Tone Switch, S-Meter. For 200/250 v. A.C./D.C. Internal loop and telescopic antennae fitted. Valve line up: 12BE6, 12BA6, 12AV6, 50C5, and metal rectifier. Size 13½ × 8½ × 5½in. Instruction manual included.

LASKY'S PRICE £24.15.0 Carriage FREE

H.P Terms £2/9/6 dep. and 11 months at £2/5/0.

LAFAYETTE TAPE

Famous American Brand—Fully Guaranteed at record low prices. In sealed cartons.

5in. Double play, 1,200ft. Mylar base	15/-
5in. Long play, 900ft. Acetate base	10/-
5in. Standard play, 600ft. P.V.C. base	8/6
5½in. Long play, 1,200ft. Mylar base	15/-
5½in. Double play, 1,800ft. Mylar base	22/6
5½in. Long play, 1,200ft. Acetate base	12/6
5½in. Standard play, 850ft. P.V.C. base	11/6
7in. Standard play, 1,200ft. Mylar base	12/6
7in. Long play, 1,800ft. Mylar base	19/6
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3in. Message tape, 150ft.	3/6
3in. Message tape, 225ft.	4/11
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P. & P. 1/- extra per reel; 4 reels and over Post Free.
Full range of triple play tape available.

SPECIAL PURCHASE

MAKER'S SURPLUS SWITCHED F.M. TUNER

Made by Dynatron—Model FM 2 I.V. Provides 4 preset stations selected between 88-100 Mc/s. Fully adjustable to your local frequencies. 7 valve circuit with Foster Seeley discriminator and A.G.C. Valve line up: 5 × Z719, 1 × B719 and D77. Unpowered—requires 250 v. D.C. at 45 mA. and 6.3 v. at 2.5 a. 75 ohm aerial input. Size 6½ × 5½ × 5½in. Brand new and unused individually boxed. A superb unit—maker's list price was £24/5/-.

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LOWEST PRICES EVER!

All Complete with Styli L.P. and Standard (and Stereo where shown) fully guaranteed. Standard Fitting will fit most P.U. Arms and Heads. Postage 1/- extra each.

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Garrard Magnetic T.O.M.2	15 0
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Acos GP.67/1	14 0
STEREO Acostereo 73/1, with 2 sapphires	25 0
Acostereo 73/2, with Diamond LP/Stereo and sapphire Std.	29 6
Collaro type C Turnover, with 2 sapphires	19 11
Collel S.C.1. Turnover, with 2 sapphires	19 11
Collel S.C.1. Turnover, with Diamond LP/Stereo and sapphire Std.	25 0
Ronette Stereo O.V. Turnover, with 2 sapphires	25 0
Ronette Stereo type 105 and 106 with 2 sapphires	25 0
Ronette Stereo type 105 and 106 with Diamond LP/Stereo and sapphire Std.	35 0

The "Sixteen" Multirange METER KIT

This outstanding meter was featured by *Practical Wireless*, in the Jan. '64 issue. Lasky's are now able to offer the complete kit of parts as specified by the designer. All British components are used throughout. The instrument case is supplied with the meter movement built-in. The two scales are clearly printed in black on white and are very easy to read.

RANGE SPECIFICATION

D.C. volts: 0-2.5-25-50-250-500 at 20,000Ω/V.
A.C. volts: 0-25-50-250-500 at 1,000Ω/V.
D.C. current: 0-50μA, 0-2.5-50-250 mA.
Resistance: 0-2000Ω, 0-200 kΩ, 0-20 MΩ.
Basic movement: 40μA f.s.d. moving coil. With universal shunt full scale deflection current is 50μA.
Size/finish: Black plastic case—3¾ × 5¾ × 1¾in.
Controls: 12 position range switch; separate slide switch for A.C. volts—D.C. ohms; ohms zero adjustment pot. meter; meter zero. External connections: Two 4 mm. sockets for test lead plugs.
Power requirements: One 15v. and one 1.5v batts.
Complete with all parts and full construction details.

This offer is exclusive to Lasky's Radio!

LASKY'S PRICE £5.19.6 P. & P. 5/-.

H.P. Terms: 21/- deposit and 5 monthly payments of 21/-.

Data and circuit available separately 2/6 refunded if all parts bought. Pair of batteries 2/5 extra.

GUITAR PICK-UP

Crystal—high imp. Size only 1¼in. × ⅛in. × ⅛in. Clips to finger board—no screws. Complete with cable.

LASKY'S PRICE 15/11 P. & P. 1/-.

ALL THE LATEST EQUIPMENT FROM THE AUDIO FESTIVAL

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NO INTEREST TERMS
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TAPE DECK MOTORS

Motors for the Collaro Studio Deck—new and unused. 200-250 v. A.C. Take-up, rewind and capstan. Listed at £2/5/- each.

LASKY'S PRICE 14/11 each P. & P. 2/6.

Set of three 35/-. P. & P. 6/-.

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Size: 4in. dia. × 2in. high 1in. × ¼in. spindle.

LASKY'S PRICE 19/11 P. & P. 3/6.

TAPE POSITION INDICATOR

Open type—as used by most makers. With re-set knob
3 DIGIT 7/6. 4 DIGIT 10/6. P. & P. 9d. on each

HI-FI TAPE RECORDER HEADS

High Impedance Record Play. Low impedance erase. Upper or lower track **LASKY'S PRICE 29/6.** Post free per pair. State track required when ordering.

MARRIOTT "X" Type ¼ track heads. Record/Play and Erase. **LASKY'S PRICE 4 GNS. pair.**
¼-Track heads Record/Play and Erase 59/6 pair.

RECORDING TAPE SPLICER

By famous manufacturer, all metal nickel plated construction. With separate razor blade, securely clamps tape while splicing. Listed at 18/6.

LASKY'S PRICE 14/6 Post Free.

EXPORT MODEL—SUPER TV OFFER

625 line T.V. chassis (Export Model). For 200-250v A.C./D.C. mains. Fitted with Band I-III turret tuner. Fully loaded with 12 sets of coils for all CCIR channels in these bands. F/M sound. Made by famous British manufacturer. 15 Mullard valves. Electrostatic focus and deflection. Will take 17in., 19in., 21in. or 23in. CRT. All controls fitted. Supplied new and unused with all valves, 7in. × 4in. speaker and 17in. CRT (less cabinet).

LASKY'S PRICE £25 Carr. & packing FREE to any part of the World. (Tube sent at buyer's risk). An allowance of £1 will be made if the CRT is not required. Circuit data included FREE.

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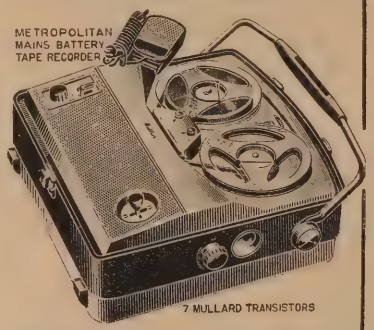
"WALTER" METROPOLITAN

MAINS/BATTERY TAPE RECORDER

Maker's list price 55 Gns.

OUR PRICE £25 Carr. & Ins. 15/- ex.

Double your fun with this revolutionary tape recorder. It makes you independent of mains electricity supplies; yet it's full size and gives you BIG 2-WATT OUTPUT and faithful reproduction on batteries or mains, plus all the advantages of mains or battery recording indoors—outdoors—anywhere—everywhere.

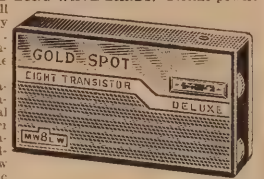


BRAND NEW in maker's cartons. Thoroughly tested before despatch. Just some of the wonderful features of the "Metropolitan":—A.C. mains 100/250 v. or 9 Ever-Ready PP9 or Vidor VT9 dry batteries (by each battery). Twin-track. Hi-Fi perfection with enough volume to fill a small hall on mains or battery. 3¾ i.p.s. Rev. counter. Record safety button. 7 × 4in. high flux speaker. Magic-eye indicator. Mixing and superimposing facilities. Outputs for external speaker and amp. Reel size 5¾in. max. Weight only 17½ lbs. Overall dimensions 14 × 13¾ × 5¾in. Complete with 850ft. tape, spools, radio/gram, recording leads and plugs. Hi-Fi microphone. Instruction booklet and SERVICE MANUAL.

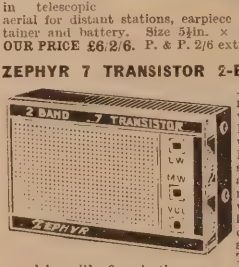
TRANSISTOR RADIO SETS!

GOLD SPOT EIGHT TRANSISTOR DE LUXE

MEDIUM AND LONG WAVE BANDS. Terrific power. Stations roll in. Extremely sensitive. Beautifully finished two tone plastic case with Gilt speaker fret. Complete with real brown leather case which incorporates additional screw in telescopic aerial for distant stations, earpiece in separate container and battery. Size 5¼in. × 3¼in. × 1¼in. **OUR PRICE £6/2/6.** P. & P. 2/6 extra.



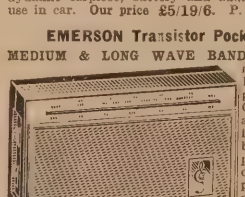
ZEPHYR 7 TRANSISTOR 2-BAND RADIO



A de-luxe 2-band radio for Medium wave 535-1605 Kc/s. and Long wave 160-280 Kc/s. The transistors as fitted are American made and provide power and long distance reception a pleasure in listening. Two tone cabinet, complete with fine leather case and wrist strap, dynamic earpiece, battery and additional aerial for use in car. **Our price £5/19/6.** P. & P. 2/6 extra.

EMERSON Transistor Pocket Radio

MEDIUM & LONG WAVE BANDS. Extremely nice design in Blue or Red plastic case with Gilt speaker fret and dial. Excellent tone. With battery and earpiece. Carrying case is not supplied with this model. Size 5in. × 3in. × 1¼in.



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by A.R.R.L.

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Lab.A/EV26A	£20 11 1	41/1	30/10	22/2
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AT6/EV26A	£12 5 5	25/5	18/4	13/2
LEAK NEW MODEL				
Stereo 20/Vari.	£55 9 0	111/-	83/2	59/8
TL12 Plus/Vari.	£34 13 0	69/-	52/-	37/4
Troughline	£29 7 6	59/6	44/-	31/7
LENCO				
GL 58 Gram	£17 1 9	34/-	25/7	18/4
GL70 Gram	£27 9 4	54 4	41/3	29/7
GOODMANS				
Axiette 8	£5 5 7	10/7	7/11	5/8
Axiom 10	£6 5 11	12/11	9/5	6/9
Maxim	£17 10 6	35/6	26/3	18/10
Eleganza II	£27 10 0	55/-	41/3	29/7
DULCI				
S55 Mono	£27 3 3	55/3	40/8	29/2
S55s Stereo	£30 17 11	62/11	46/3	33/2
MISCELLANEOUS				
Cadet Stereo	£26 15 0	55/-	40/-	28/8
Decca FFSS Ster.	£18 17 11	37/11	28/4	20/4
DeccaDeramA.E.1.	£11 11 0	24/-	17/3	12/5
W.B. 1012	£4 7 6	9/6	6/6	4/8
W.B. 1016	£7 0 6	14/-	10/6	7/7

Showroom hours: Monday-Saturday 10 a.m.-5 p.m. Directions: No. 6 bus from Liverpool St. Station to Odeon, Hackney Rd., walk back two turnings.

A. L. STAMFORD Ltd (DEPT. H4) Phone: SHO 5003

98 Weymouth Terrace, London, E.2.

9WW—178 FOR FURTHER DETAILS.

HARVERSON SURPLUS CO., LTD.

Also see facing page.

Another Harverson Bargain!

REMOTE CONTROL UNIT AND SPACE CONTROL AMPLIFIER.

Originally intended for remote channel changing and volume control of T.V. receivers by supersonic waves. Comprises of remote hand control unit, supersensitive mike and amplifier with 5 Mullard valves (2-ECC83, EB91, PCC89, EZ80). Supplied complete in maker's original cartons, brand new and unused with full circuit diagram etc. Easily adaptable for hundreds of uses where remote control of apparatus is required without direct connection. Maker's list price 18 gns. **LIMITED NUMBER AVAILABLE AT ONLY 37/6** P. & P. 5/-. *The relays, valves, mike, transformers and components are worth far more than our price for the complete units and due to the very high value and the limited number we regret that no correspondence can be entered into regarding these items.*

BRAND NEW 3 OHM LOUDSPEAKERS

2½in. **12/6**; 5in. **12/6**; 6½in. **15/-**; 8in. **21/-**; 10in. **25/-**; 12in. **27/6** (15 ohm 12 inch **30/-**).
E.M.I. 2½in. tweeter **10/6**
10in. x 6in. **26/-**
Latest type E.M.I. 13½in. x 8in. speaker with high flux ceramic magnet. 11,000 gauss. Aluminium centre cone. 10 watts, 50 c/s to 10 Kc/s. **42/-** P. & P. up to 6in. **1/6**; over 6in. **2/6** per speaker

SPEAKER AND CABINET FABRICS

Oatmeal or Red and Gold Vynair for speaker and cabinet covering, also Red Rexine for cabinet covering only. All 54in. wide and usually sold at 35/- yard. OUR PRICE **13/6** per yard length. plus P. & P. 1/9 per yard. (Minimum order 1 yard.) Send S.A.E. for samples.

TAPE DECKS

B.S.R. MONARDECK (Single speed) 3¾in. per sec., simple control, uses 5¾in. spools, **£6/15/-**, plus 5/6 carr. and ins.
COLLARO STUDIO DECK £10/10/- plus 5/6 carr. and ins. (Tapes extra on both.)

HARVERSON'S BARGAIN CORNER!!

MAINS TRANSFORMER

Drop thru' type. Tapped primary 110 v., 200 v., 220 v., 240 v., 320-0 v., 320 v. at 80 mA. and 6.3 v. at 3 amps. Generous core. Stack size 3¾ x 2¾ x 1¾in. Weight 4lb. ONLY **15/-**. P. & P. 3/6.

ACOS CRYSTAL MIKES. High imp. For desk or hand use. High sensitivity, **18/6.** P. & P. 1/6.

TSL CRYSTAL STICK MIKE. Listed at 45/-. Our price **18/6.** P. & P. 1/6.

CARBON MIKE INSERTS. Brand new, 2½in. dia., **3/6.** P. & P. 9d.

STANDARD COLVERN 50K. W/W Pre-set Pots. 2 for **4/-**. P. & P. 1/-.

TRANSISTOR DRIVER and O/P TRANSFORMERS. (Tapped 3 ohms and 15 ohms output). plus 4 suitable Transistors giving approx. 1 watt output, **30/-**. P. & P. 2/-.

T.C.C. SUPPRESSOR CONDENSERS. 250v. A.C. .005+.005 × .1. In tubular can. 1¾in. long × ¾in. dia. 2 for **3/-**. Post free.

5,000 MFD. 12 V. WKG. CONDENSERS. Size 3 x 1in. diam. **2/-** each. P. & P. 6d. each.

BRAND NEW PLESSEY. 12v. 4-pin, non-sync. VIBRATORS. Type 12, 1.4.SD. ONLY **8/6.** P. & P. 1/6 each.

3-PUSH BUTTON SWITCH UNIT. 4 single pole changeover on each push-button. Approx. 3 × 1¾ × ¾in. An absolute Bargain at **4/6** each. P. & P. 1/- each.

MARCONI QUARTZ CRYSTALS. Types ZHB. Still available as previously advertised.

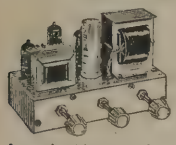
SPECIAL SPEAKER BARGAINS

ROLA-CELESTION approx. 9in. x 6in., 3 ohm middle register speaker, **10/6.** P.&P. 2/6. **FEW ONLY.** 6in. x 4in. 3 ohm Speakers. Only 9/-. P. & P. 1/- per speaker.
8in. x 5in. 3 ohm SPEAKERS BY WELL-KNOWN MAKER. Unrepeatable at only **10/6** each. P. & P. 1/6. per speaker. A pair of these are ideal for Stereo.

9WW—179 FOR FURTHER DETAILS.

3-VALVE AUDIO AMPLIFIER

MODEL HA34



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. x 4in. d. x 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls.

The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only **£4.5.0** P. & P. 4/-.

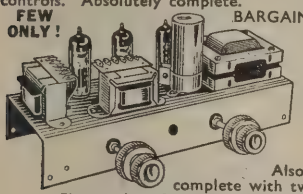
TWO VALVE GRAM AMPLIFIER ON PRINTED CIRCUIT BOARD.

(UY85, UL84.) Can be used with 80v. tap off motor. O.P. trans. Volume and Tone Control. Size 6½in. wide x 2in. deep x 3½in. high overall. **ONLY 39/6.** P. & P. 2/6. Mains dropper res. for filaments if required, **2/6.**

STEREO AMPLIFIER

Incorporating 2 ECL82s and 1 EZ80, heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.

FEW ONLY! BARGAIN PRICE



89/6 P. & P. 5/-.

Also available complete with two 8in. x 5in. speakers for only **£5/10/6.** P. & P. 6/6.

6 TRANSISTOR AND DIODE SUPERHET

A first-class 2 wavebands transistor superhet. ● Printed circuit panel (size 8⅛ x 2¾in.). ● 3 pre-aligned I.F. transformers. ● High-gain Ferrite rod aerial. ● All First-grade transistors. ● Car aerial winding. ● Push-pull output. ● All parts supplied with simple instructions.

All parts sold separately.

Set of parts if purchased at one time.

ONLY £4.5.0 P. & P. 2/6

35 OHM SPEAKERS

Suitable for use with above. 2in. Goodmans. Ideal replacement for most pocket portables **8/6**; 3¼in. **12/6**; 5in. **17/6**; 7 x 4in. **21/-.** P. & P. 1/6 per speaker.

Portable CABINET

Size approx. 9½ x 6¾ x 3¼in. Suitable for above using 3¼in. speaker, **25/-.** P. & P. 2/-.

COIL AND TRANSFORMER SET FOR TRANSISTOR SUPERHET

3 I.F. transformers, one oscillator coil, one driver transformer and wound Ferrite aerial (med., long and aerial coupling), **32/6** complete, post 1/-. 6 transistor printed circuit board to match, **8/6**, post 9d. Circuit diagram **1/6** extra.

SPECIAL TRANSISTOR BARGAINS ALL BRAND NEW

GET 15 (Matched Pair) **15/-**

OC71... 5/-	OC76 ... 6/-	XA103...	6/6
OC72... 6/-	PXA101 ...6/6	V15/10p	...12/6

Set of Mullard 6 transistors, OC44, 2-OC45, OC81D matched pair, OC81 **25/-.**

EDISWAN MAZDA

R.F.1 Pack: 1—PXA102 Mixer; 2—PXA101 I.F. Amp.; (Equiv. OC44 and OC45)..... **10/6**
R.F.2 Pack: 2-PXA101 I.F., 1-PXA102 Osc.; 1-PXA102 Mixer **12/6**
L.F.6 Pack: Consisting of PXB113 Driver, Matched pair PXC171, mounted complete with heat sinks (Equiv. OC81D and OC81) ... **12/6**

ALL TRANSISTORS POST FREE.

QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs ECC83, EL84, EZ80 valves. Bass, treble and volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 2½in. d. x 5½ in. h. Ready built and tested.

PRICE 69/6. P. & P. 3/6.

ALSO AVAILABLE mounted on board with output transformer and 6in. speaker ready to fit into cabinet below. **PRICE 89/6.** P. & P. 4/6.

QUALITY PORTABLE RECORD PLAYER CABINET

Uncut motor board. Will take above amplifier and B.S.R. or GARRARD Autochanger or Single Record Player Unit. Size 18 x 14 x 8½in.

PRICE £3/9/6. Carr. 5/-.

SUPERIOR CABINET. To take 8 x 5in. speaker, with motor board will accommodate BSR UA14 or UA16, **£3/9/6.** Carr. 5/6. Speaker **10/6** extra. P. & P. 1/6 extra. **LARGE CABINET.** Similar to above with 3 ohm speaker, **£3/9/6.** Carr. 5/-.

4-SPEED PLAYER UNIT BARGAINS

All brand new in maker's original packing.

SINGLE PLAYERS

B.S.R. TU/12 ..... **£3/10/-.** Carr. 3/6.
B.S.R. GU7 with unit mounted pickup arm. **£4/18/8.** Carr. 4/-.

AUTO. CHANGERS

B.S.R. UA14 ..... **£6 2 6**
Latest B.S.R. UA16 ..... **£7 2 6**

LATEST GARRARD AUTO-SLIM with heavy duty 4-pole motor. FEW ONLY **£7/7/-.** (Standard Auto-Slim **£6/17/6**). Carr. 5/- on each.

BRAND NEW CARTRIDGE BARGAINS!

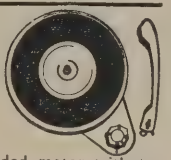
B.S.R. TC8S High output compatible STEREO CARTRIDGE. Brand new. Complete Stereo/L.P/78 sapphire stylii and universal mounting bracket. Original list price **44/11.** Our price **22/6.** P. & P. 1/-.

RONETTE STEREO 105 CARTRIDGE Stereo/LP/78 complete with two sapphires. Original list price **67/9.** Our price **24/-.** P. & P. 1/-.

COLLARO HI-FI STEREO CERAMIC t/o CARTRIDGE Type "C" complete with universal bracket and styli for stereo, L.P. and 78. Original list price **59/8.** Our price **25/-.** P. & P. 1/-.

E.M.I. 4-speed Player and P.U.

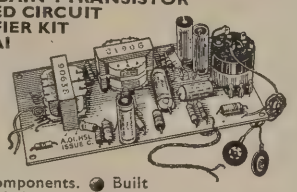
FURTHER HUGE PURCHASE enables us to offer these at 67/6 P. & P. 4/6.



Heavy 8¾in. metal turntable. Low flutter performance 200/250 v. shaded motor with tap at 45 v. for amplifier valve filament if required. Turnover LP/78 head.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT

Type TA!

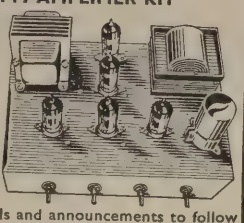


● Peak output in excess of 1½ watts ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114 or S1 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 1/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE 45/-.** P. & P. 2/6. Also ready built and tested, **52/6.** P. & P. 2/6. A pair of TAIs are ideal for stereo.

SPECIAL PURCHASE! TURRET TUNERS by famous maker

Brand new and unused. Complete with PCC84 and PCF80 valves, 34-38 Mc/s. I.F. Biscuits for Channels 1 to 5 and 8 and 9. Circuit diagram supplied. ONLY **25/-** each. P. & P. 2/6.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **1/6.** (Free with parts.) **All parts sold separately.** ONLY **£6/19/6.** P. & P. 6/6. Also available ready built and tested complete with standard input jack sockets, **£8/15/-.** P. & P. 6/6.

FOR THE HOME CONSTRUCTOR

A really excellent all purpose A.C. mains 200/240 v.

AMPLIFIER KIT.

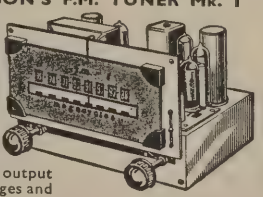
TYPE HSL 'FOUR' 3 VALVE, 4 WATT USING ECC83, EC84, EZ80 VALVES.

Special features include.

★ Heavy duty double-wound mains transformer with electrostatic screen.
★ Separate Bass, Treble and Volume controls, giving fully variable boost and cut with minimum insertion loss.
★ Heavy negative feedback loop over 2 stages ensures high output at excellent quality with very low distortion factor.
★ Suitable for use with guitar, microphone or record player.
★ Provision for remote mounting of controls or direct on chassis.
★ All this builds onto a chassis size only 7½in. wide x 4in. deep. Overall height 4¾in.
★ All components and valves are brand new.
★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success.
★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder, etc.

(No extras to buy). PRICE **79/6.** P. & P. 5/-. Comprehensive circuit diagram, practical layout and parts list 2/6 (free with kit).

HARVERSON'S F.M. TUNER Mk. I



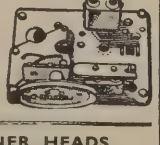
● F.M. tuning head by famous maker. ● Guaranteed non-drift. ● Permeability tuning. ● Frequency coverage. 88-100 Mc/s. ● OA81 balanced diode output discriminator. ● Two I.F. stages and ● Attractive maroon and gold dial (7 x 3in. glass). ● Self powered, using a good quality mains transformer and valve rectifier. ● Valves used ECC85, two EF80s, and EZ80 (rectifier). ● Fully drilled chassis. ● Size of completed tuner 8 x 6 x 5¼in. ● All parts sold separately. Set of parts if purchased at one time **£5/19/6,** plus 8/6 P.P. and ins. Circuit diagram and instructions 1/6 post free. **Mark II Version** as above but complete with magic eye. front panel and brackets, **£6/12/6.** P. & P. 8/6.

Mark III Version as Mark I but with output stage (ECL82) and tone control. **£7/7/-.** P. & P. 8/6.

Handsome Metal Cabinets. Choice of Grey, Black or Green. To fit Mark I, **25/-.** P. & P. 2/6. To fit Mark II, **17/6.** P. & P. 2/6.

F. M. TUNER HEAD

A permeability tuned tuner head by a famous maker supplied without valve (ECC85) and drum and spindle. **18/6,** plus 1/9. P. & P. Valve **8/6** extra. Drum and spindle **3/6** extra.



GÖRLER F.M. TUNER HEADS

10.7 Mc/s I.F.

15/-, plus 1/9 P. & P. (ECC85 valve, 8/6 extra).

LOOK OPPOSITE FOR MORE BARGAINS

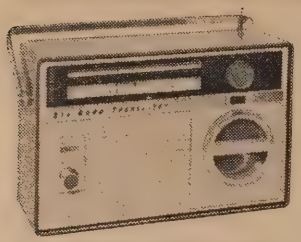
HARVERSON SURPLUS CO. LTD.

170 HIGH ST., MERTON, S.W.19. CHErrywood 3985

Open all day Saturday *Early closing Wed., 1 p.m.*

A few minutes from South Wimbledon Tube Station. *(Please write clearly)*

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA. (Please enclose stamped addressed envelope with all enquiries)



THE SKYROVER AND SKYROVER De Luxe

GENERAL SPECIFICATION FOR BOTH MODELS

7-transistor and 2-diode superhet—6 waveband portable receiver, covering the full Medium Waveband (180-576 M.) and Short Waveband (32-94 M.) and in addition 4 separate switched Band Spread Ranges on 13M., 16M., 19M. and 25M. Bands—with manual Band Spread Tuning for accurate Station selection. L.F. frequency 470 Kc/s. Output 500 M.W. 5in. Ceramic Magnet P.M. Speaker. Telescope and internal Ferrite Rod Aerial. All Mullard Transistors and Diodes. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our detailed and easy to follow instructions. Operates on four 1.5 v. torch batteries (U2 or equivalent).

THE SKYROVER DE LUXE. Tone Control Circuit is incorporated with separate Tone Control in addition to Volume and Tuning Controls and Waveband Selector. In sturdy wood cabinet, size 11½ × 6½ × 3in., covered in washable material with plastic trim and carrying handle. Also Car Aerial socket.

MAY BE BUILT FOR All parts sold separately. £12.19.6

H.P. Terms: 26/- deposit and 11 months at 24/6.

Circuit diagram and data for each set 2/6 extra, free if all parts bought. Four U2 batteries included free.

Add 5/- P. & P. on each parcel.

THE SKYROVER. Individual Details—Controls: Waveband Selector, Volume Control with on/off switch. Tuning Control with easy to read Dial Scale. In attractive plastic cabinet, size 10 × 6½ × 3½in., with metal trim and carrying handle.

MAY BE BUILT FOR All parts sold separately. £10.19.6

H.P. Terms: 22/- dep. & 11 months at 21/-.

H.M.V. 45 r.p.m. AUTO RECORD PLAYER

Takes only 45 r.p.m. 7in. discs. Plays up to 8 automatically. Fitted with lightweight pick-up and crystal cartridge. Mounted on sturdy plinth—size 10 × 10 × 5in. For 200/250 v. A.C. mains.

WIRECOMP'S PRICE 59/6

P. & P. 3/6.

250MW TRANSISTOR AMPLIFIER

Suitable for use with the above changer.

WIRECOMP'S PRICE 35/-

Battery 2/6 extra. **P. & P. 2/6.**

Suitable 6 × 4in. speaker, 12/6 Post Free.

The transistor amplifier can be incorporated in the plinth of the changer with the speaker—thus making a self contained Record Player. **£5.9.6 POST FREE**

Can be purchased together for

TAPE LAFAYETTE BRAND, FULLY G'TD. LOWEST PRICES EVER.

5in. Double play, 1,200ft. Mylar base	15/-
5in. Long Play, 900ft. Acetate base	10/-
5in. Standard play, 600ft. P.V.C. base	8/6
5½in. Long play, 1,200ft. Mylar base	15/-
5½in. Double play, 1,800ft. Mylar base	22/6
5½in. Long play, 1,200ft. Acetate base	12/6
5½in. Standard play, 850ft. P.V.C. base	11/6
7in. Standard play, 1,200ft. Mylar base	12/6
7in. Long play, 1,800ft. Mylar base	19/6
7in. Double play, 2,400ft. Mylar base	25/-
7in. Long play, 1,800ft. Acetate base	15/-
3in. Message tape, 150ft.	3/6
3in. Message tape, 225ft.	4/11
3in. Message tape, 300ft.	7/6

P. & P. 1/- extra per reel: 4 reels and over Post Free.

TRIPLE PLAY TAPE ALL SIZES SOON AVAILABLE

THE 'SPRITE'

A six-transistor superhet Miniature Pocket Radio of Commercial Quality. Fully tunable over Long and Medium wavebands. Uses printed circuit and high sensitivity internal ferrite rod aerial. I.F. frequency 470 Kc/s. Transistors: 3 Philco 2067s, 2 Mullard OC81M, OC81DM and OA90 diode, 3in. speaker. Works on single PP3 battery. Supplied with the complete RF and IF stages, driver and output stages, ready built and mounted on the printed circuit—for final assembly you have only to fit the wave-change switch, tuning condenser and drive, volume control, earphone socket and aerial rod. In very attractive plastic case, size 4 × 2½ × ¾in.

MAY BE BUILT FOR 79/6 All parts sold separately.

Real Calf Leather Case, wrist strap and Personal Earphone with case, and battery, **12/6** extra.

P. & P. 3/6 extra. (Data and instructions 2/6, free if all parts bought.)

THE 'REALISTIC 7'

A fully transistorised Portable Receiver made to the highest professional standards. Comprises 7 Mullard Trans., OC44, OC45's, OC71, OC81D, and 2 OC81's plus OA70 Crystal Diode. Delivers 350 milliwatt output to 4in. high flux speaker—I.F. frequency 470 Kc/s.—fully tunable over medium and long wavebands. All components mounted on single printed circuit board, size 5½ × 5½in. Attractive two-tone plastic cabinet with carrying handle—size 7 × 10 × 3½in., with easy to read dial and socket for car aerial, choice of Blue/Grey or all Grey. Complete with full instructions.

MAY BE BUILT FOR £5.19.6 All parts sold separately. Battery 3/9 extra.

P. & P. 4/6 extra. (Circuit diagram 2/6, free if all parts bought.)

AND 'REALISTIC 7' DE LUXE

Available with the same specification as the standard model PLUS a restyled superior cabinet, AND ALSO a full vision circular tuning dial.

Only £1.0.0 extra P. & P., etc., as Standard Model.

8 WATT MONO AMPLIFIER

Made by well-known manufacturer. **Spec.:** 2-EL84, 1-EZ80 and 1-ECC83 Push-pull output. Separate Bass and Treble controls on panel with extended lead.

WIRECOMP'S PRICE £5.5.0 P. & P. 3/6.

ALSO AVAILABLE AS STEREO AMPLIFIER. 4 watts per channel—two speaker outputs.

ONLY £6.19.6 P. & P. 5/- extra.

THE PETIT FULMITER

A.C. Eliminator and 9 v. Battery Charger. (Approx. same size as PP3 battery.)

WIRECOMP'S PRICE 18/6 P. & P. 1/6.

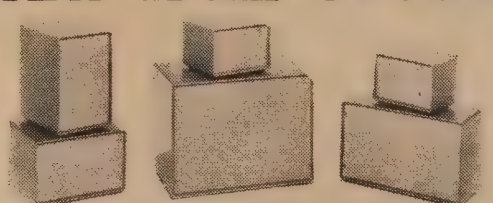
WIRECOMP ELECTRONICS

378 HARROW ROAD, LONDON, W.9. TEL.: CUNNINGHAM 9530

Hours of Business: 9 a.m. to 6 p.m. Open all day Saturday. Opposite Paddington General Hospital. Buses 18B & 36 pass the door.

9WW—181 FOR FURTHER DETAILS.

NEW from OLSON



MODERN CASES FOR MODERN REQUIREMENTS

The firm of Olson Electronic Ltd. have found need for small instrument cases in the industry and are introducing a series of small cases designed to satisfy the demands of miniature assemblies. These are strongly made of 20 s.w.g. mild steel and finished in silver-grey hammertone stove enamel with front panel in light grey (shade 631) high gloss enamel.

Rubber feet are fitted to all cases. Vent panels can be fitted at a small extra charge.

TYPE	WIDTH	HEIGHT	DEPTH	FRONT PANEL
25A	6¼in.	4¼in.	4¼in.	18 swg
25B	6¼in.	4¼in.	6¼in.	18 swg
26A	8¾in.	5¾in.	6¼in.	18 swg
26B	8¾in.	5¾in.	8¼in.	18 swg
27A	12¼in.	7¼in.	5¼in.	16 swg
27B	12¼in.	7¼in.	8in.	16 swg
28A	14in.	10¼in.	6¼in.	16 swg
28B	14in.	10¼in.	8¼in.	16 swg

NEW SIZES OF INSTRUMENT CASES (STANDARD SIZES)

TYPE	WIDTH	HEIGHT	DEPTH	
29A	10in.	4in.	6in.	18 swg
29B	10in.	4in.	8in.	18 swg
30A	12in.	5in.	6in.	18 swg
30B	12in.	5in.	8in.	18 swg
31A	14in.	6in.	6in.	18 swg
31B	14in.	6in.	8in.	18 swg

STANDING CASES

40A	4¼in.	6¼in.	6in.	18 swg
40B	5¾in.	8¼in.	6in.	18 swg
40C	5¾in.	8¼in.	8in.	18 swg

Quotations gladly given for customers' own specifications and special requirements

OLSON ELECTRONIC LIMITED, 54 Myddleton Street, LONDON, E.C.1 Telephone: TERminus 8081

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TRANSISTORS

OA5	6/-	OC19	25/-	OC47	30/-	OC81	5/6
OA6	5/6	OC22	23/-	OC57	16/-	OC82	10/-
OA7	6/-	OC23	33/6	OC58	17/6	OC83	4/-
OA10	8/-	OC24	29/-	OC59	18/6	OC84	8/-
OA70	3/-	OC25	12/-	OC60	17/6	OC122	16/-
OA73	3/-	OC26	25/-	OC65	22/6	OC123	20/-
OA79	3/-	OC28	24/6	OC66	25/-	OC139	8/-
OA81	2/-	OC29	25/6	OC70	6/6	OC140	19/-
OA85	3/-	OC30	40/-	OC71	4/8	OC141	31/-
OA86	4/-	OC35	12/-	OC72	5/6	OC169	10/-
OA90	3/-	OC36	21/6	2xOC72 Matched Pair	16/-	OC170	8/6
OA91	3/-	OC41	8/-	OC73	16/-	OC171	9/-
OA95	3/6	OC42	6/-	OC74	8/-	OC200	10/6
OA200	5/-	OC43	12/6	OC75	5/6	OC201	29/-
OA202	5/6	OC44	5/-	OC76	8/6	OC202	24/6
OA210	9/6	OC45	5/-	OC77	12/-	OC203	13/-
OC16W	35/-	OC46	27/6	OC78	8/-	OC204	19/-
				OC79	8/-	OC205	30/-
						OC206	30/-

AD140	25/-	
AF102	27/6	
AF114	11/-	
AF115	10/6	
AF116	5/-	
AF117	9/6	
AF118	20/-	
AF124	11/-	
AF125	10/6	
AF126	10/-	
AF127	9/6	
GET113	6/9	
GET114	8/6	
GET115	9/6	
GET116	17/-	
GET120	30/-	

SETS OF TRANSISTORS

Set No. 1: Comprising OC44, 2 x OC45, OC81. Matched pair OC81, **20/-.**

Set No. 2: Comprising OC81, Matched pair, OC81, **10/-.**

ALPHA RADIO SUPPLY CO.

103 LEEDS TERRACE, WINTOUN STREET, LEEDS 7

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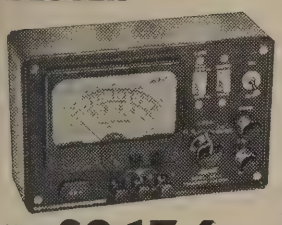
NEW TEST EQUIPMENT

TRANSISTOR TESTER



FULLY PORTABLE PRECISION INSTRUMENT

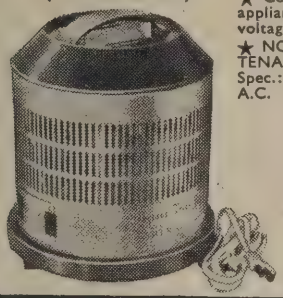
MEASUREMENT RANGES:
Ico (Icbo) and the reverse current of diodes.
PNP & NPN—0~50μA (1μA per scale).
POWER—0~1mA (20μA per scale).
β5-200 (5 per scale)
Bias current—
(1mA on PNP & NPN)
(5mA on POWER)
α0.9-0.995 (from $\beta = \frac{\alpha}{1-\alpha}$)

Terminals: **Spring Sockets and Screw Terminals.**
Meter: 4in. 50μA moving coil.
Size and Weight: 7 x 5 x 3in. 2½lb
Powered by pen cells.

Model AT-1 **£9.17.6** P. & P. 5/6

CONSTANT VOLTAGE TRANSFORMER

AUTOMATIC MAINS STABILIZER
(DUAL VOLTAGE)

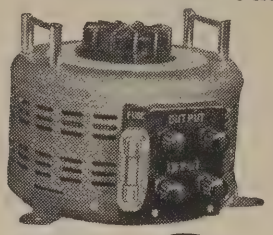


PROVIDES PERFECTLY STABILIZED CONSTANT VOLTAGE FOR ALL LABORATORY EQUIPMENT.

★ Completely protected from damage if appliance is short-circuited, output voltage reduces to nil.
★ NO MOVING PARTS. ★ NO MAINTENANCE. ★ NO ATTENTION.
Spec.: *Input:* 180-260 v. A.C. & 85-125v. A.C.
Output: 240 v. A.C. and 115 v. A.C.—50/60 cycles.
Capacity: 250 VA
Accuracy: ±1%. *Size:* 8 x 8in.
Weight: 21 lb. Complete with lead and plugs, in attractive vented metal case with leather handle.

£11.10.0 Carr. 12/6.

VARIABLE VOLTAGE TRANSFORMERS
World Famous "SLIDUP"

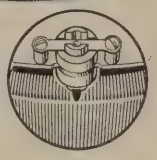


★ *RATED CURRENT CONSISTENT AT ALL POINTS ALONG THE WINDING.*

Output: 0-260 v. *Input:* 230 v. A.C. 50/60~

Shrouded fully variable transformers for bench or panel mounting.

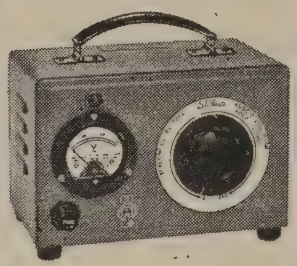
2.5 Amp. ...	**£5.17.6**
5 Amp. ...	**£9. 0.0**
10 Amp. ...	**£18. 5.0**
20 Amp. ...	**£32.10.0**



Model SB10 10 amp.

Inset shows latest type brush gear providing 1 volt variation.

PORTABLE VARIABLE A.C. POWER SUPPLY UNIT



Designed for engineers whose requirements call for a visual indication of volts applied.
Output: 0-260 v. 1½ amps.
Input: 230 v. A.C. 50/60~. Unit fitted with fuse, voltmeter, safety indicator, on-off switch and lead.
Size: 8" x 5" x 5" high.

PRICE **£7.15.0** P. & P. 5/6.

IMMEDIATE DELIVERY

ALL ITEMS FULLY GUARANTEED

SUPPLIED COMPLETE WITH VALVES & CRYSTALS
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'88' Set WALKIE TALKIE

Produced to exacting specifications by leading manufacturers E. K. Cole & Co.

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£10.0.0 EACH

This Transmitter/Receiver weighs only 5½lb. (approx.) and measures 3½in. x 5½in. x 9½in.

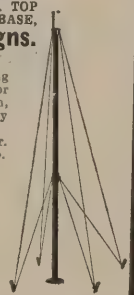
A crystal controlled 4 frequency set operates from standard dry battery—H.T./L.T. (i.e. Vidor L5537, 14 current series B7G valves used.

AERIAL MASTS

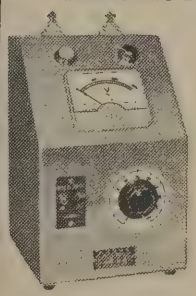
NEW IMPROVED TUBULAR AERIAL MASTS CONSISTING OF SIX, 6FT. SECTIONS 1¼IN. DIA. TOP CAP WITH PULLEY, AND HALYARD, BASE, PICKETS, GUYS AND ALL FITTINGS. 12½ gns. Returnable wood case 20/- extra, refundable. Carr. (Inland) 17/6.

20FT. TELESCOPIC MAST. NEW self supporting all steel tubular 4 section Masts suitable for Roof or Wall fixing, as well as Base location, can be extended to full height or locked at any position.
Bottom section approximately 1¼in. diameter. Copperised and Sprayed finish. Weight 16lb.
Price £5/0/0 Carr. 7/6.

LIMITED QUANTITY 36FT. BRASS TELESCOPIC MAST COMPLETE WITH BUILT-IN HAND WINDING WINCH FOR EASY RAPID EXTENSION. Finest quality. Non-rusting. Bottom section 2¼in. dia. Winds down to 9ft. One of the best masts ever produced.
Price £35/0/0 Carr. 30/-.



VARIABLE HIGH-VOLTAGE UNIT
DIELECTRIC BREAKDOWN TESTER

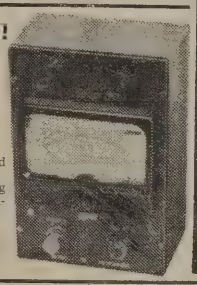


★ ***Range:*** Infinitely variable up to 3,000 volts and can be accurately set. 0.1 amp.
★ Entirely suitable for continuous testing.
★ Built-in Automatic safety cut-out.

Input: Mains voltage.
Robustly constructed for bench use with 4½in. x 4in. modern styled meter, placed at an easy to read angle. Complete with input and test leads with clips.
Model T30, 0-3,000 v. A.C. **£32.**
Model T50, 0-5,000 v. A.C. **£40.**

TRANSISTORIZED MEGOHMETER

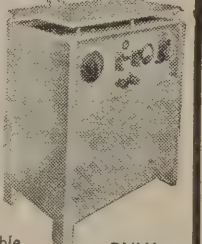
NO WINDING! PUSH-BUTTON TO READ



500V.-1,000 MEGOHMS
Portable, supplied c/w batteries, probes and carrying case. Superb instrument.

ONLY £19.10.0

20 AMP 24 VOLTS HEAVY DUTY SUPPLY UNIT



Made at a cost of approx. £100/0/0 by S.T. & C. LTD.
Essential equipment for Electronic Engineering, Research Laboratories, Schools. Ideal for battery charging, etc. Guaranteed for 20 amps.
Output: 24 VDC variable up to 20 amps. and trickle charge.
Input: A.C. 100/260 v. 45/65 cycles. Input & output fully fused.
Size: 16 x 24 x 32in. high. In heavy gauge steel grey cabinet.

ONLY **£27.10.0**
Packing & Carr. 40/-

I.M.O. LTD. (Dept. WW8), 2-5 POWIS MEWS, WESTBOURNE PARK ROAD, LONDON, W.11
BAYswater 1756

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Head Office: 44a, Westbourne Grove, London, W.2

Tel.: PARk 5641/2/3 **Cables: ZAERO, LONDON**

A.R.B. Approved for inspection and release of electronic valves, tubes, klystrons, etc.

RETAIL BRANCH (personal callers only): 85 TOTTENHAM COURT ROAD, W.2. Tel.: LANgham 8403

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R.D.O. UHF/EHF RECEIVERS

This is an I.F. (300 Mc/s.) five-stage amplifier followed by A.F. and video stages. R.F. tuning is provided by interchangeable Tuning Heads or Units which cover frequency range of 38 to 4,000 Mc/s. Receiver . . . I.F. sensitivity is 15μV. approx. for an output of 6 mV. I.F. bandwidth is 4 Mc/s. Audio response can be set at 150-10,000 c/s (broad) or 320-1,950 c/s (narrow). Provisions are made for connecting the receiver to a Panoramic Adaptor (for observing frequency spectra) or to a Pulse Analyser. Power requirements—115 v. A.C. PRICE, fully overhauled and guaranteed, complete with Tuning Units TN1B, TN2B, and TN3B to cover frequency range from 40 to 1,000 Mc/s. **£110 0 0**

Packing and carriage £2/10/-.

MARCONI FM-AM SIGNAL GENERATORS

TF948 (SERVICES TYPE No. 13). Frequency range 20-80 mc/s. in two bands. Built-in crystal calibrator with loudspeaker beat indicator. Continuously variable output from 1μV to 100 mV. into 75Ω and fixed high output of 1 volt.

Internal modulation at 300-1,000-1,600-3,000 c/s.; A.M. up to 80% and F.M. up to ±600 kc/s.; square wave 50—50. Provision for external modulation. Both A.M. and F.M. modulation can be monitored with an accuracy of approx. 5% F.S.D. Power supplies 100-150V. and 200-250V. A.C. Signal generator chassis is shock-mounted in a pressed steel case, fitted with screw-down cover which can be used as tranist case.

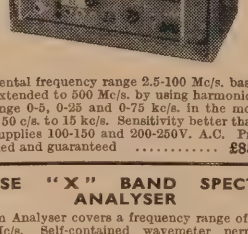
Price, fully overhauled and guaranteed is..... **£220**

MARCONI TF144G "STANDARD" SIGNAL GENERATORS

Frequency Range 85 kc/s. to 25 mc/s. Incremental frequency control. Calibration accuracy ±1%. Output voltage 1μV to 1V. Internal modulation 400 c/s. up to 75% depth. Output impedance 10Ω and 52.5Ω. Fully overhauled to the original specification, complete with R.F. lead with Dummy Aerial and Mains lead **£85 0 0**

Ditto with additional coils to extend the range down to 15 kc/s thus covering a band of 15 kc/s. to 25 Mc/s. Calibration charts are provided with these coils which are read in conjunction with the logging scale of the tuning dial **£95 0 0**

MARCONI FT934 DEVIATION TEST SET



Fundamental frequency range 2.5-100 Mc/s. basic; range can be extended to 500 Mc/s. by using harmonics. Deviation range 0-5, 0-25 and 0-75 kc/s. in the modulation range of 50 c/s. to 15 kc/s. Sensitivity better than 55mV. Power supplies 100-150 and 200-250V. A.C. Price fully overhauled and guaranteed **£85 0 0**

TSX-4SE "X" BAND SPECTRUM ANALYSER

Spectrum Analyser covers a frequency range of 8,360 to 9,550 Mc/s. Self-contained wavemeter permits the tuning of the instrument with an accuracy of ±4 Mc/s. It can be used for observing spectra of pulsed oscillators, for measuring frequency, for checking frequency pulling in the magnetrons and for measuring standing waves and attenuation.

PRICE, fully overhauled and guaranteed.. **£190 0 0**

Packing and carriage £2/10/-.

GENERAL RADIO LR.2 COMBINED HETERODYNE FREQUENCY METER AND CALIBRATOR EQUIPMENT

Frequency range 160 kc.-60 mc. and 0-5,500 c/s. In the latter range, the instrument will also work a radio oscillator with an output of 3V. into 600 ohms. Precision 100 kc. crystal accurate to ± 1 cycle drives a multivibrator providing check-points at 100, 20 and 10 kc. Direct reading interpolator indicating the different frequency between the measured signal and the wavemeter setting. Power supplies 120 V. A.C. **Price £110 0 0**

Packing and Carr. £3.

EVERSHED 250 V. "WEE" MEGGERS

Perfect condition. Complete with case **£14 10 0**

WAVE ANALYSERS

MARCONI TF455D/1. Direct measurements of components of complex waveforms of between 30μV and 300V. in the frequency range of 20 c/s to 16 kc/s. Accuracy ±2% ± 10 c/s. for frequency and ± 5% average for voltage. **£120.**

HEWLETT PACKARD 300A, specification as above but for input range of 1 mV. to 500 V. **£100.**

THOMSON VARLEY POTENTIAL DIVIDERS

Non-inductive 4-decade potential divider with total resistance of 70,000Ω. Maximum input voltage 300 V. Built-in galvanometer 1μA F.S.D. **£45.**

R.P.M. INDICATOR KIT

Radio-Altimeter Indicators with moving coil movement of 5 mA. F.S.D. easily convertible to accurate engine R.P.M. indicators. Supplied complete with parts required for conversion, and detailed instructions. Suitable for 4 cylinder engines with 12 v. electrical installation. **45/-.** P.P.

VARIABLE AUTO-TRANSFORMERS Type B-2

Input 230 v. A.C. 50-60 c/s. Output adjustable from 0 to 260 v. at a maximum current of 2.5 amps. Scale graduated in volts. Dimensions: 5¼in. dia. × 4¼in. high. Fixing: Three .2in. dia. holes on a pitch circle of 5¼in. dia. PRICE, brand new..... **£5 19 6**

Packing and carriage 11/6.

AERIALS 'Electron' Outdoor Aerial

3 strong tubular light alloy sections 3ft. long each on an insulated aerial base fitted with wall mounting bracket. Complete with down lead. PRICE, brand new, **15/-.** P.P. 5/-.

Aerials for Wireless Set No. 31

2-section collapsible Aerial with flexible mounting, 33in. long extended **7/6**

8-section collapsible Aerial, 10ft. 8in. extended, folds down to 17 in. **15/-**

BATTERY CHARGERS

HY-GRADE Home Battery Chargers with an output of 4 amps for 6V. or 12V. batteries. 2in. Ammeter. Dimensions 6in. × 8in. × 4in. Complete with fuse, A.C. leads, D.C. leads, with crocodile clips and instructions. Suitable for 200/250V. mains. **49/6.** Post paid.

VACUUM DELAY RELAYS

Glass envelope (G.T. shape), octal base, thermal delay relays, type 6-030. 6V. heaters. Nominal delay 30 seconds. One set of "make" contacts of 5 amps capacity. **9/-.**

PORTABLE MOVING IRON VOLTMETERS

160 v. A.C./D.C. Mirror scale instruments having scale length of approx. 8in. New **£3 0 0**

Packing and carriage 15/-.

RADIO FREQUENCY THERMO-COUPLE METERS

200 mA. 2in. Round, plug-in	12/6
350 mA. 2in. Round, plug-in	12/6
1 amp. 2½in. Round, projecting	15/-
2.5 amps. 2in. Round, panel mtd.	25/-
2.5 amps. 2in. Square, flange	25/-
3 amps. 2in. Round, panel mtd.	25/-
3 amps. 2in. square, flange	25/-
4 amps. 2in. Round, flange	20/-
10 amps. 2½in. Round, flange	22/6
15 amps. 2½in. Round, flange	22/6

PAPER BLOCK CAPACITORS

.1μF 5000v	4/-		1000v	5/6	350v 3/-
.25μF 500v	3/6		1500v	6/-	400v 3/6
4000v	10/-		2500v	12/6	600v 5/-
7500v	20/-	2 μF	400v	3/-	750v 7/-
.5μF 1200v	3/6		600v	3/6	900v 7/6
2500v	5/-		800v	4/-	1200v 9/-
5000v	12/6		2500v	15/-	8μF 350v 6/-
1μF 400v	2/6	4μF	150v	2/-	800v 10/-
600v	2/8		200v	2/6	2500v 25/-
800v	5/-		250v	3/-	

METERS PHILIPS FIRST-CLASS MIRROR SCALE 1 mA. D.C. MC METERS

Square flange 4.6in. × 4.6in. flush mounted. Scale length 4in. Body 3.8in. dia. × 1⅞in. deep. Calibrated 0 to 1 mA. PRICE..... **65/-**

Other calibration supplied at an extra charge.

MINIATURE METERS

GENERAL ELECTRIC, 1¼in. Round flush clip mounted Moving Coil Meters:

1 mA. D.C.	30/-
25 mA. D.C.	25/-
75, 100, 150 mA. D.C.	20/-

"INTERNATIONAL" SUBMINIATURE "PENNY SIZE" METERS 1in. Round Flush ring nut mounted. 500μA. FSD., Calibrated 0 to 1 mA. **22/6.**

REMANENT TELEPHONE CROSSBAR RELAYS

The relay consists of 5 cross-bar Units of 8 make contacts each, operated by separate 820Ω coils and one 1,000Ω main coil of the P.O. 3000 Type. The latter is fitted with two sets of auxiliary changeover contacts.

PRICE, brand new (p. & p. 5/-) **35/-**

POST OFFICE RELAYS TYPE 600

6000Ω, 1M + 1C.O., new..... **10/-**

SEALED RELAYS, BRAND NEW

CR2791, 100Ω, 1 C.O., USM5 Base	8/-
55190, 300Ω, 1 C.O. Lug Base	8/-
90327, 2,500Ω, 1 C.O., Lug Base	12/6
MH1769, 270Ω, 2 C.O., I.O. Base	7/6
BOHRX 20, 445Ω, 2 C.O. (H.D.), I.O. Base	7/6
B8743-1, 680Ω, 2 C.O., Lug Base	7/6
SKHX 377, 9,000Ω, 4 M, 10-pin Base	12/6
5724-132HSX, 400Ω, 4 C.O., Lug Base	8/6
C8940-1, 250Ω, 5 B, 11-pin base	12/6
22240-4, 200Ω, 6 M, 14-pin base	10/-

PLESSEAL PAPER CAPACITORS Wire Ended

.1μF 250V; .47μF 150V; 1μF 150V; PRICE **10/-** per dozen assorted. Postage 1/6.

PLESSEY ELECTROLYTIC MOTOR START CAPACITORS

275/334μF, 150V A.C. **2/-** each.

LARGE CAPACITY ELECTROLYTICS

8,000μF 50V **6/-**; 20,000μF 25V. **8/-**; 25,000μF 25V. **8/-**; 39,000μF 10V. **10/-**.

POST OFFICE RELAYS TYPE 3000

2000Ω, 2 Breaks	10/6
2000Ω, 4 Change-overs	12/6
2000Ω, 6 Change-overs	15/-
6500Ω, 1 Make	10/6
8800Ω, 2 Makes + 1 Break	12/6

'DOUGLAS' CHARGER TRANSFORMERS Input 200-250 volts

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Smooth stepless control of DC motors—without sacrificing high efficiency operation—by means of thyristors (silicon controlled rectifiers) is described in May INDUSTRIAL ELECTRONICS, now on sale—one of many articles showing how electronics can cut costs and increase productivity throughout industry. INDUSTRIAL ELECTRONICS is vital to all who must use electronics to meet ever-increasing competition. Other articles in the current issue are summarised below; June issue will include **Manufacturing Multi-Range Meters.**

ALSO IN MAY ISSUE:

Digital Techniques in Industry
Application of digital techniques to control of a simple injection moulding machine.

Instruments, Electronics & Automation Exhibition 1964
Some of the interesting equipment on show at Olympia, London, May 25-30.

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FOR each grade an appropriate standard of technical training and of operating and maintaining radio and electronics equipment will be required.
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RADIO and television servicing engineer required for appointment as instructor (unestablished) but with prospects of eventual establishment at the Perivale Government Training Centre. Applicants must be British subjects who are (a) experienced and fully skilled in their trade, including thorough knowledge of basic radio and television theory, combined with considerable practical experience of fault finding, aligning, adjustment and servicing of commercial radio and television receivers; (b) able to instruct from first principles and to demonstrate use of bench tools and repair of components; and (c) able to supervise the work and maintain control of trainees. Applicants should have undergone the training usual in their trade, followed by practical experience on fully skilled work (normally for at least five years) and should preferably possess O.N.C. or equivalent qualifications.
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COMMENCING salary £1,064+£50 L.W. (at age 30 or over) rising to £1,147+£50 after two years.
APPLICATION forms (S.E.107) are obtainable on personal application from any Employment Exchange or by post from the Regional Controller, Ministry of Labour, Hanway House (Room 317), Red Lion Square, London, W.C.1.
THE closing date for the receipt of completed application forms (quoting reference number 007) will be 30th May, 1964.
THE theory test will be held on 8th June and the Selection Panel Interview on 22nd June, 1964. [2839

ELECTRONIC ENGINEERS.

VACANCIES exist for electronic engineers and test engineers to work on the design and development of transistorised pulse and digital equipment; a sound knowledge of the subject is required, together with the drive and initiative to see a project through to production.—Apply to Mr. Dixon at Speedwell 4651 (Electronic Applications (Commercial), Ltd.). [2826

AN OVERSEAS CAREER WITH

INTERNATIONAL AERADIO LIMITED.
TO meet the requirements of constant growth and expansion we invite applications from technicians and engineers for an overseas career in North, West and East Africa, the Mediterranean area, the Caribbean, the Arabian Gulf and the Far East. If you have recently completed service in a trade such as Ground Wireless Fitter in the R.A.F. or Radio Electrical Artificer in the Royal Navy or have other experience in the maintenance of HF and VHF communications, RTT and navigational aids, we should be interested to hear from you. Successful candidates would normally spend six weeks at our Radio Training School, Southall, Middlesex, before proceeding overseas, but in some cases staff with suitable qualifications and experience may be offered immediate posting. Overseas staff receive a tax-free salary with married and child allowances if appropriate and accommodation, bachelor or married, is provided free; other benefits include generous U.K. leave and membership of an excellent pension and life assurance scheme.
WRITTEN applications, please, to Personnel Officer, 40, Park St., W.1. [0084

ELECTRONIC INSTRUMENTATION

The expansion of Plessey-UK Limited is reflected in the growth of our Test Gear Department where vacancies at various levels offer challenging and rewarding opportunities.

DESIGN AND DEVELOPMENT ENGINEERS will find considerable scope for their activities in the field of electronic test equipment and instrumentation, including automatic and semi-automatic test methods. The Company's activities cover communications equipment in the range 1 to 400 Mc/s., aircraft electrical and marine equipments, and other diverse products. We seek both Senior and Intermediate personnel and whilst qualifications of H.N.C. standard are desirable, emphasis should be placed upon the need for a background of sound experience.

CALIBRATION ENGINEERS are required to carry out the checking and calibrating of a wide range of electronic test gear and—

MAINTENANCE ENGINEERS are needed for the repair and routine maintenance of this equipment.

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Attractive salaries. Excellent conditions. Pension and Life Assurance Scheme.

Letters of application should be addressed to:—
The Employment Manager, Plessey-UK Limited, Ilford, Essex.

Plessey UK

THOMSON TELEVISION (INTERNATIONAL) LTD.

requires a fully experienced radio and television engineer as Assistant to the Technical Director. He will assist in preparing plans for developing radio and television services in all parts of the world, and must have wide broadcasting experience and be thoroughly competent in all aspects of studio design, transmitter surveys and propagation studies. He will be resident in the U.K. and paid £2,500 per annum, with three weeks holiday and top hat pension benefits. Applicants should apply in writing, giving full details of experience and qualifications, to

The Technical Director, Thomson Television (International) Ltd., Thomson House, 200, Gray's Inn Road, London, W.C.1.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY
WINDSCALE AND CALDER WORKS

INSTRUMENT MECHANICS

Windscale and Calder Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitudes analysers, counting circuits, television and industrial instruments used for the measurement of pressure, temperature and flow.

Men with at least five year Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information.

Rate of pay £14/5/- rising to £15 per week.

Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing.

Write for details, quoting reference BP.195 to:—
Works Labour Manager, U.K.A.E.A.,
Windscale and Calder Works, Sellafield, Seascale, Cumberland.

TESTERS

required for interesting work on L.F. and H.F. Transmitters. Previous fault-finding experience essential.

The positions available would be of special interest to persons employed in the fault-finding and repair of television who are keen to establish themselves in a position that offers:

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Multitone Electric Co. Ltd.
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FLIGHT simulator engineer at the College of Air Training, Hamble, Southampton. Essential to have experience of maintenance of electronic equipment including DC analogue computers, instruments and servo-mechanisms. Knowledge of principles of flight and aircraft systems desirable. Salary scale £1,030-£1,180. Contributory staff pension schemes. Enquiries in writing to Bursar, giving age, qualifications and a summary of previous experience. [2840

MAINTENANCE Engineer required for American equipment unique to U.K., engineer about 25 years of age with good general electronics experience and some knowledge of computers. Adequate training will be given. Apply in writing giving full particulars of age, qualifications and previous experience to—Group Personnel Manager, Wood Pritchett & Partners, Ltd., Boundary House, Boston Road, London, W.7. [2847

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY
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DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING.

A Senior or Chief Laboratory Technician is required with experience of the installation and maintenance of Stage lighting, Public address systems and visual aids.

Applicant should have a Higher National Certificate in Electrical Engineering or Telecommunications, or equivalent.

Salary within the range £870-£1,270 subject to age, qualifications and experience. Permanent, pensionable.

Applications stating age, qualifications, experience and present salary to the Head of Department

PRINCIPAL ENGINEER

The Marine Systems Division of Plessey-UK Limited, which is involved in designing and developing complex electronic equipment for marine applications, is now expanding and requires a Principal Engineer to lead a team providing general engineering services including the preparation of equipment specifications, user handbooks, and post design services.

This post is one of responsibility and offers an interesting and rewarding challenge to an engineer with organising ability. Please reply, giving details of qualifications and experience and quoting Ref. 7727 to the Employment Manager, Plessey-UK Limited, Vicarage Lane, Ilford, Essex.

Plessey UK

SENIOR ENGINEER (TELEVISION BROADCASTING).
THE Thomson Foundation Television College requires a Senior Engineer (Television Broadcasting). This is a newly created post in a television training establishment for overseas students.
APPLICANTS must have considerable previous experience at a Senior level in television studio operations and maintenance, together with a real and practical interest in all other aspects of television technical operations.
DUTIES will include maintenance of studio and master control equipment, the operation and demonstration of technical facilities required for programme production, and some instruction.
SALARY in the range £1,550-£1,750 per annum. Superannuation scheme.
APPLICATIONS with full details of television experience to the Principal, Thomson Foundation Television College, Kirkhill House, Newton Mearns, Glasgow. [2833

Are you interested in Instruments or Electronics and their application to aircraft?
The College of Aeronautics offers an opportunity for an enthusiastic young man to learn new techniques in flight test instrumentation. Tidiness, ability to handle delicate instruments and attention to detail are essential. The successful applicant will, after a probationary period of training, take charge of a small laboratory and be responsible for calibration and installation of flight test instruments in the College aircraft.
The post is established in a skilled grade in accordance with the N.J.C. scales for Civil Aviation.
Applications giving full particulars to **Chief Clerk, The College of Aeronautics, Cranfield, Bletchley, Bucks.**

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1. Have you a detailed knowledge of up-to-date electronic circuits using either valves or transistors???

2. Can you apply your knowledge logically and systematically in diagnosing faults in circuits?

3. Are you able to test electronic equipments to detailed specs. using standard test methods and techniques???

If you can confidently answer 'YES' to all three questions, whether fully-qualified academically or not

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Then write to:

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* SINGLE sideband equipment.
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WE require trained personnel for production testing and fault finding of modern equipment.
WE have limited vacancies for more senior and experienced men with drive, who can lead small teams engaged on this work.
WE have also limited vacancies for persons of less experience who can be trained for such work.
APPLY to: The Personnel Manager. [0340

RADIO engineer/mechanic, first-class communications work, required large company engineers, 1-2 years' service overseas, excellent opportunity; write, age, experience.—Box 5306. [2821

NORTHERN POLYTECHNIC, Holloway, London, N.7.
THE Governing Body invites applications for appointment as Lecturer in the Department of Electronics & Telecommunications. The Lecturer will be expected to cover the graduate syllabus of the Brit.I.R.E. and Part III of the I.E.E. and should hold a degree of a British University or equivalent qualification and/or be a Corporate Member of an appropriate professional engineering institution. Previous teaching and industrial experience an advantage. Salary scale.—£1,670×£45×£1,895 plus London Allowance £45/60.
APPLY for further particulars and form of application.
R. H. CURRELL, F.C.A., Clerk. [2845

WANTED, licensed aircraft radio engineer, interesting and varied work.—Apply Rogers Aviation, Great Barford, Bedford. [2825

YOUNG audio-engineer required by a leading recording studio for technical duties, experience of magnetic recording would be an advantage.
APPLICATIONS in writing to: Universal Programmes Corporation, Ltd., 35, Portland Place, London, W.1. [2841

EXPLORATION geophysics. Men under 30, well qualified in electronics, with a H.N.C., or higher degree or Dip. Tech education, are offered permanent positions with a firm of Geophysical Consultants operating from the U.K. in Europe but more frequently in remote corners of the world.
THE successful applicants will be employed initially in the U.K. and must be prepared for assignments of up to two years out of the U.K. They should be single preferably and have a real desire to enter Geophysics as a career.—Apply Box 5305. [0034

CHANGE TO COMPUTERS!

I.C.T. have outstanding opportunities for electronics engineers

This is a chance for electronic engineers to develop a full working knowledge of the most advanced electronic computers made in this country. We want experienced men (aged 24 to 32) to work as Field Engineers in the London and home counties area. These are permanent positions with good salaries and real scope for advancement. Holidays, sick pay and retirement schemes are unusually good.

YOU NEED THESE QUALIFICATIONS

An ability to handle bench tools and instruments.
An understanding of the effects of electrical and electronic wants on complex mechanisms.
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If you are interested in a rewarding career with I.C.T., please write giving full details of education, qualifications and experience quoting reference F.E.3 to **The Personnel Section, Field Engineering Division, International Computers and Tabulators Limited., 85/91 Upper Richmond Rd, Putney, London, SW15**

ICT

LABORATORY TECHNICIANS

required at the
CENTRAL ELECTRICITY
RESEARCH LABORATORIES

Leatherhead, Surrey.

FOR WORK IN THE PHYSICS DIVISION which is developing automatic control systems concerned with the generation and transmission of electricity and also with advanced forms of communications and telemetry. Technicians are required to construct and test electronic equipment and systems associated with the experimental work with the minimum of supervision.

Applicants should have full craft training and have had several years' experience or be fully conversant with the construction of prototype electronic equipment, preferably with model shop experience. A qualification at least comparable with O.N.C. would be an advantage.
REF. W.W. 141

FOR WORK IN THE ELECTRONICS SECTION which will include construction and testing of mechanical components for UHF and microwave systems in accordance with Engineers' sketches and instructions.

Applicants should have either served a craft apprenticeship or had equivalent training and experience in similar work. Possession of an O.N.C. or comparable qualification and some experience of electronics, would be an added advantage. REF. W.W. 142

Salaries on a scale within the range **£695** to **£1,125** per annum, according to qualifications and experience.

Applications stating age, qualifications, experience, present position and salary to N. Berryman, Personnel Officer (Headquarters), Central Electricity Generating Board, 24/30, Holborn, London, E.C.1 as soon as possible.

AIRCRAFT Radio Engineers and Mechanics with specific workshop experience in one or more of the following: VHF, ILS/VOR. 42-hour week (40-hr. week commencing 1st October). Salary according to ability. Pension Scheme. Overtime and Bonus system. Apply: Managing Director, Air Transport (Charter) (C.I.), Ltd., Willow Road, Poyle Trading Estate, Colnbrook, Slough, Bucks. The inexperienced need not apply. [2788

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Redifon, Ltd., Broomhill Rd., S.W.18. [0252

WAR DEPARTMENT, 33, Central Workshop Reme, Newark, Notts. TELECOMMUNICATIONS mechanics for overhaul of wireless equipment, starting range of pay £12/1 to £13/3; progression beyond this according to service and qualification; five-day 42-hours working week, opportunities for external training and promotion.—Apply to Officer Commanding, 33 Central Workshop R.E.M.E., Lincoln Rd., Newark, or local office the Ministry of Labour, quoting reference 33/CW/1. [0167

THE following posts have arisen in our company in connection with out latest expansion programme.
(a) ASSISTANT to chief inspector (electronic section), applicants should possess:—
1. DRIVE and ability to control and supervise inspection staff and introduce inspection methods to achieve the quality level required.
2. A KNOWLEDGE of manufacturing, test methods and quality control sampling systems.
3. ABILITY to supervise, investigate and analyse fault finding of electronic equipment.
4. CITY and Guilds Radio II, Radio B or 4th year H.N.C. electrical higher or equivalent qualifications, or a background of broad and varied technical experience in electronics.
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Shell International Marine

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A new appointment will shortly be created in the Application and Development Division of the above Company.

The man appointed will be concerned with the development of the advanced telecommunication and navigational equipment used by Shell's Tanker Fleets. The work will involve extensive travel at sea and in maintaining contact with manufacturers internationally; it will call for imagination backed by a sound knowledge of modern radio and electronic techniques and by experience of development work. Particular experience in the marine field will be an advantage but is not regarded as essential.

Applications are invited from men between the ages of 25 and 35 who hold a good honours degree in Electrical Engineering or Electronics.

The conditions of service are good and there is a generous pension scheme.

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Shell International Marine Limited,
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Shell Centre, London, S.E.1.

DEVELOPMENT ENGINEER

required to join Laboratory working on the Development and Engineering of Data Transmission Systems.

also

Assistant Development Engineer

to join Radio Laboratory working on VHF, UHE and SHF Telecommunications Equipment including Solid State Amplifiers, etc.

For Full Details Of These Posts Apply

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A. T. & E. (BRIDGNORTH) LTD.,
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EMI

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These posts call for men who possess a background of three years' electronic maintenance experience. Applications from experienced TV service engineers and ex-Service radar personnel are particularly invited.

Interviews 9 a.m.-4 p.m. Monday to Friday or early evening appointments can be arranged.

Please apply quoting Ref. WW/E/30/B9.

Group Personel Manager,
04213/S/P,
E.M.I. LIMITED,
Blyth Road, Hayes, Middlesex.

RADIO & Television Testers.
FOR City Factory; good rates up to 7/6 per hour; five day week.
APPLY to Personnel Manager:—
ALBA (RADIO & TELEVISION), Ltd., Tabernacle St., London, E.C.2. [0012

TESTROOM Engineers (Senior and Junior), experienced in Audio and Public Address Equipment test methods.—Apply: Mr. R. Bradford, Grampian Reproducers, Ltd., Hanworth Trading Estate, Feltham, Middlesex. [2781

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AEI

vacancies exist for

ELECTRICAL TESTERS

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Please apply to:—
The Personnel Officer, Ref. 251, Associated Electrical Industries Ltd., Woolwich Road, Woolwich, S.E.18. Telephone WOO 2020

EMI

ELECTRONIC STAFF

Applications are invited for the following interesting positions in the laboratories of **E.M.I. Electronics Ltd.** at Feltham and Hayes, Middlesex, and Wells in Somerset.

TEST ENGINEERS and Assistant Test Engineers to be engaged on a wide range of Ministry equipment developed and manufactured by the Company.
Location: Hayes, Feltham and Wells. *Ref. WW/E/9/12*

CALIBRATION ENGINEERS to be concerned mainly with the calibration and maintenance of a variety of Electronic Test Gear.
Location: Hayes and Feltham. *Ref. WW/A/5/5c*

TRIALS ENGINEERS to be concerned in assisting in the development and trials of a wide range of electronic instrumentation equipment.
Location: Feltham. *Ref. WW/P/8/11a*

Applicants should have a sound basic knowledge of electronics preferably to City & Guilds standard and some knowledge of modern transistor techniques. Consideration will, however, be given to technicians who have worked on Radio and T.V. servicing or in the technical branches of H.M. Forces who wish to broaden their experience.

Please apply in writing, quoting appropriate ref. no. to:

Group Personnel Manager, 04213/S/P,
E.M.I. Limited, Hayes, Middlesex.

TECHNICAL WRITERS

Expansion of the Marine Systems Division of Plessey-UK Limited has created vacancies for technical writers to prepare maintenance manuals and other literature on a variety of electronic and electro-mechanical equipments. A practical knowledge of radio and radar techniques is desirable and previous experience of technical writing in these or similar fields is essential. These are permanent appointments and attractive salaries are offered. Please reply, in confidence, giving details of qualifications and experience and quoting Ref. 7726 to the Employment Manager, Plessey-UK Limited, Vicarage Lane, Ilford, Essex.

Plessey UK

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(Electronic Instruments)

Vacancies exist in the Production Department of an expanding Company for Electronic Test Engineers. The Company is engaged in the manufacture of high quality precision electronic instruments. Applications are invited from men possessing HNC or equivalent qualifications with experience in servicing or production testing. Opportunities for promotion, good salary and conditions are offered.

Apply in the first instance for application form to:—

Personnel Officer,
HEWLETT-PACKARD LIMITED,
Dallas Road,
Bedford.

BOURNEMOUTH EDUCATION COMMITTEE

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Principal: M. L. Yates, M.A.(Com.), M.Sc.Tech., Ph.D., M.I.Mech. E.

Full-time and part-time courses are provided in preparation for the following:—

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Institution of Electrical Engineers Part III Examination
Royal Institution of Chartered Surveyors (4 years, full-time)
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Provision is made for students' social and athletic interests and accommodation can be arranged through the College Billeting Officer.

Application for admission should be addressed to the Principal, from whom any further particulars required may be obtained. Telephone: Bournemouth 20844.

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invite applications from

ELECTRONIC ENGINEERS

for

COMPUTER MAINTENANCE

The successful applicant will be responsible for the maintenance of the equipment in a large analogue computer centre. Education to HNC standard or considerable experience is required, and a knowledge of analogue computers is desirable. Opportunities for programming are available.

Salary will be commensurate with qualifications and experience.

Detailed applications should be addressed to the Assistant Secretary (Ref: TBW/RJW) Babcock & Wilcox Ltd., 209, Euston Road, London, N.W.1.

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Top Rates and Excellent Prospects.
Telephone ADVance 5257

JUNIOR Engineer to assist in design and construction of prototype electro-medical hospital equipment; also assembly wiremen required for production.—Apply: E.M.S., Ltd., Lan. 5433. [2837

BOOKS, INSTRUCTIONS, ETC.

WANTED: Following back numbers of W.W., all '49, March and July '52, June and December '59.—Replies: J. Wilson, 28, Malone Ave., Belfast 9. [2843

WEBB'S log book for recording signals heard and worked, 112 pages, 9¾×8in, approved format, semi-stiff covers, excellent value 6/- post free, or callers 5/4.—Webb's Radio, 14, Soho St., London, W.1. [0021

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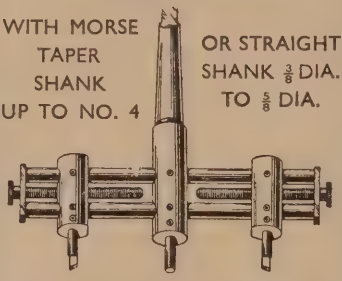

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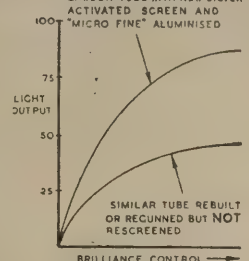

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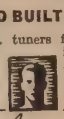

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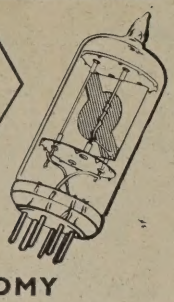

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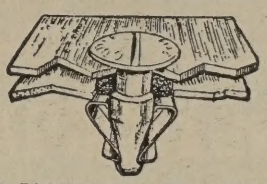

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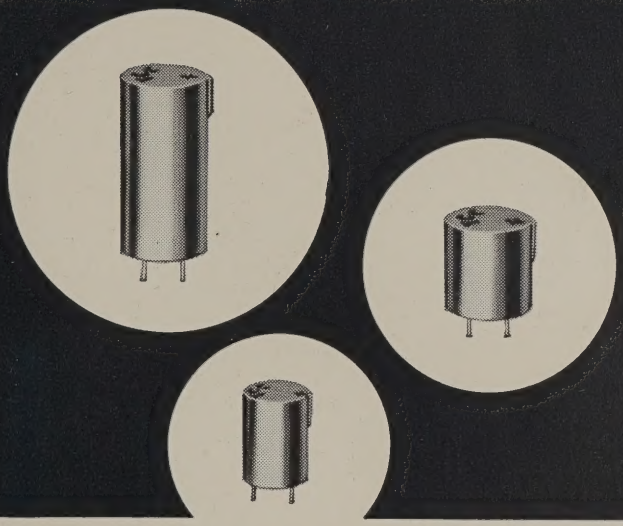

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